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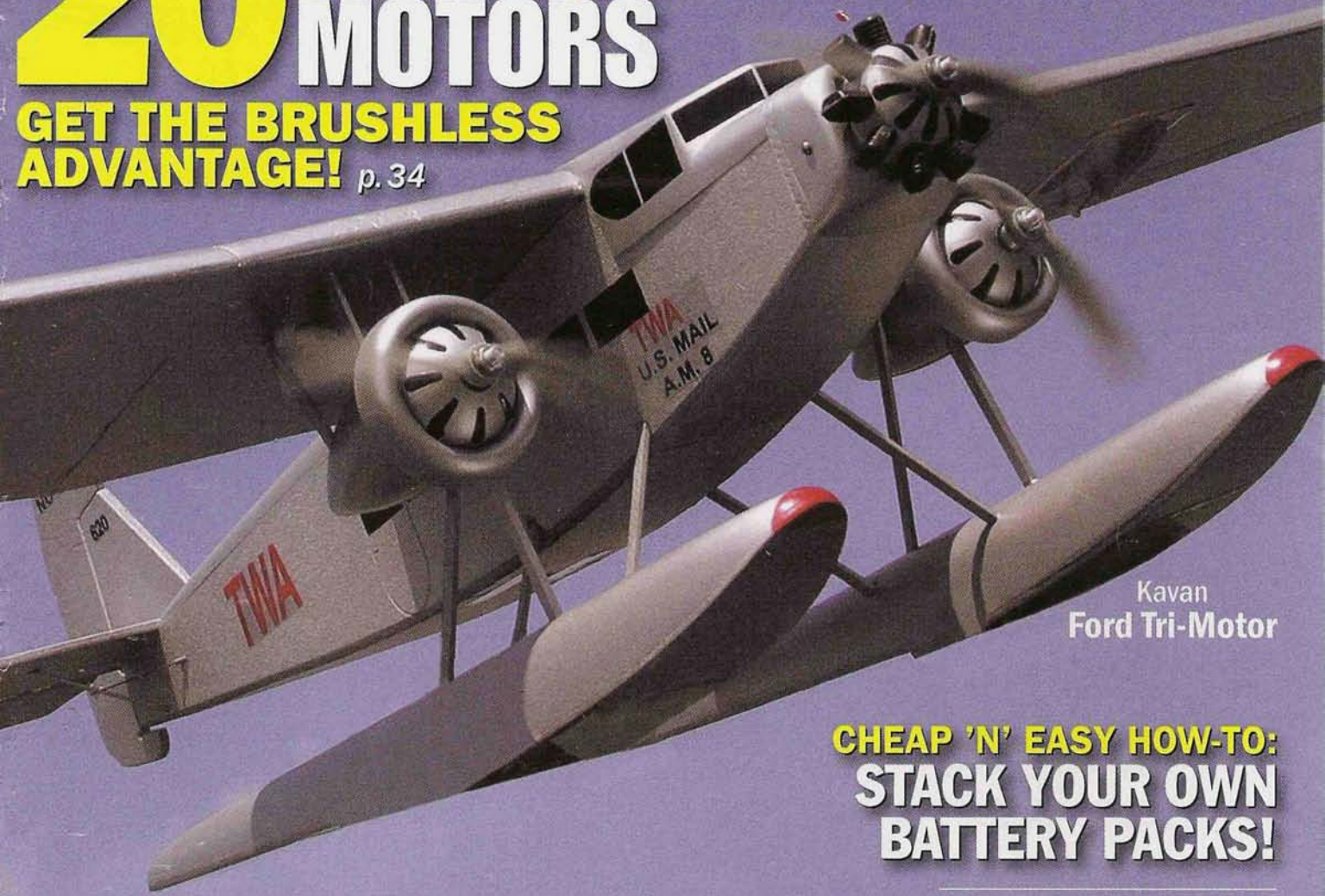
MODEL Airplane NEWS

75th ANNIVERSARY 1929-2004

20 MUSCLE MOTORS

GET THE BRUSHLESS ADVANTAGE! p. 34



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SEPTEMBER 2004

MODEL Airplane NEWS

75th ANNIVERSARY 1929-2004

SEPTEMBER 2004, VOLUME 132, NUMBER 9

FEATURES

FLIGHT TESTS

CONSTRUCTION

***ON THE COVER:** distributed by Sig Mfg,, the new Kavan Ford Tri-Motor transport is a unique electric flyer. With three motors and a set of floats, the Tri-Motor is sure to turn heads wherever you fly it! Climb aboard on page 46. On this page: Hangar 9's Extra 330S ARF—powered by a big, twin-cylinder Zenoah GT-80 gas engine—is great for all sorts of aerobatic moves! See John Reid's review on page 64.*

COLUMNS

DEPARTMENTS

EDITORIAL

BY DEBRA CLEGHORN

GET THE BRUSHLESS ADVANTAGE

You've heard the claims: brushless motors offer more power and much higher efficiency than their brushed cousins—and they last longer, too. But do these advantages justify their price tags? In a word: yes! Although brushless motors have been available for RC use for more than a decade, these high-tech electric powerplants are now offered by more manufacturers than ever before, and in sizes that easily power park flyers to giant-scale planes. You're sure to find the exact motor to suit your needs at a price that won't break the bank. In this issue's "Brushless Motor Guide," West Coast associate editor John Reid takes a close look at 20 popular brushless motors and explains exactly how they can improve your model's flight performance. He also offers a list of helpful definitions and valuable thoughts on upgrading, and he evaluates the large brushless motors that are ideal for big birds.

Successful aerobatics—especially 3D!—require the right control-surface setup. If your servos, control horns and linkages aren't secure or don't provide the right amount of surface deflection, your plane's performance will suffer—or worse. This month, in our "Freestyle Aerobatics" series, flight champion Quique Somenzini shares the secrets to his winning setups. See page 92 to learn the foundations of aerobatic success.

If the thought of designing model planes with your computer seems a bit intimidating, you won't want to miss senior tech editor Gerry Yarrish's "Thinking Big" column. Gerry has used Computer Aided Design (CAD) programs for everything from creating new designs to drawing radio and power-system setups, and he shares the basic tips and guidelines he has learned (see page 130). When you see the advantages of CAD, you may not want to go back to your paper and pencil.

Our featured construction article this month, an electric de Havilland Mosquito, is another winner from designer Mark Rittinger's hangar. With all balsa and ply construction, this 44-inch-span WW II fighter is powered by two Speed 400 motors and controlled by a 3-channel radio. Like all of Mark's designs, this one flies great and is guaranteed to impress everyone who sees it.

We're also pleased to offer the follow-up to engine expert Dave Gierke's "Glow Plugs Exposed" on page 110 of this issue. This month, Dave explains how to "read" a glow plug to get the best performance from your engine, shares solutions to common glow-plug problems and offers an interesting history of this small, yet essential, device.

Safe landings!

Debra Cleghorn

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JON CHAPPELL

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WRITE TO US! We welcome your comments and suggestions. Letters should be addressed to "Airwaves," *Model Airplane News*, 100 East Ridge, Ridgefield, CT 06877-4606 USA; email man@airage.com. Letters may be edited for clarity and brevity. We regret that, owing to the tremendous numbers of letters we receive, we cannot respond to every one.

BUYERS' GUIDE BONUS!

I just subscribed to *Model Airplane News*. Thank you for your special Buyers' Guide (August 2004) issue. As a newcomer to RC, I fly electric-powered foamies and have been looking for more information on a good, glow-powered trainer/sport model. All the kits and accessories in your guide did the trick. Many thanks for thinking of the beginners!

Clayton Moore
[email]

Clayton, we're glad you found the Model Airplane News *2004 Buyers' Guide helpful. It's good to have a handy reference source whether you're a beginner or an old pro. Good luck with your new glow-powered trainer! GY*

CLEANING LATEX PAINT

I am a regular reader of *Model Airplane News* and just finished reading both of your articles on latex painting (April 2001 and November 2003 issues). I have become very interested and would like to paint my 40-size P-51 with latex. I have only one question: after every flight, I wipe down my plane with a paper towel and Windex; will this have an effect on the paint if I clear-coat it? Thank you for your help.

Ryan Nolan
Penfield, NY

Ryan, Windex will not have any effect on the clearcoat, if you've used a good-quality clearcoat that is fuelproof (glow fuel). One suggestion: after you've finished painting the latex, make sure that it has cured fully before you apply any clearcoat over it. With some latex paints, this "full-cure" cycle can take as long as a month. To test, select a spot on the plane that has a hard, solid surface, such as the bottom of the cowl. Press on this area with your thumb and look to see whether the thumbprint remains. If it does, the paint has not fully cured. Don't worry about the thumbprint; as the paint finishes its cure cycle, the print will disappear. When the paint has fully cured, apply the clearcoat in three or four fine coats. The first coat should be a very light mist. Let this coat dry to a tacky state before you apply the next coat. Each coat after that can be a bit "wetter." The key, though, is

not to flood the latex with clearcoat. If it gets too wet, the clearcoat solvents will attack the latex. Go light and easy, and all will be fine. Good luck on your P-51 project.

Roy Vaillancourt

SHRINKING PLANS?

I have a complaint! I purchased a set of the Gary Allen-designed ¼-scale Fokker D-VII plans from RCStore.com several years ago, and I started to build from them this past winter. Your article and the description say that the model is supposed to have an 88-inch span! I measured the span, and it is only 87.75 inches! What gives? I stored my rolled plans in a drawer in my basement workshop. Did you just round up the span measurement or do you have a printing problem?

Erick Underwood
New York, NY

Erick, discrepancies in length measurement can indeed creep into model airplane plans, especially large paper plans such as Gary's Fokker D-VII. This is why our original plans—the ones that are used to make copies—are inked onto clear plastic material called Mylar. What I fear has happened to your plans is that over the years, they have shrunk because of changes in temperature and humidity levels. Mylar does not expand or shrink. Shrinking ¼ inch is not all that bad, however, and you can make the last rib bay on each wing panel ⅛-inch wider than shown and build the wings without further worry. Good luck with your project! *GY*

SUPERTIGRE G90

I just bought an older, "new-in-box" SuperTigre G90 glow engine from eBay and can't wait to put it in the nose of one of my .60-size airplanes. I have looked in back issues of *Model Airplane News* but can't find any information on this engine. Can you help me out with some basic info and recommendations for this engine? Any help would be greatly appreciated!

Thomas Bragg
[email]

Thomas, the SuperTigre line of 2-stroke glow engines manufactured in Bologna, Italy, has a reputation for producing good low-end torque. The G90 can trace its roots back to the SuperTigre .61, which was bored out to become the G75 and then enlarged once more to produce the .90ci G90. Now distributed by Great Planes, the SuperTigre engine line is experiencing new popularity, and we should be seeing more of these great ringed engines at the flying field.

If you want to learn more about this engine, you can find Mike Billinton's G90 review in the December 1996 issue of Model Airplane News. *I also converted a G90 to run on gasoline by adding a Nelson/ProSpark electronic ignition system to it. Check out my "Thinking Big" column in the July 1999 issue for more details!* *GY*

TIPS & TRICKS

Illustrations by Richard Thompson

SEND IN YOUR IDEAS. *Model Airplane News* will give a free, one-year subscription (or a one-year renewal, if you already subscribe) for each idea used in "Tips & Tricks." Send a rough sketch to *Model Airplane News*, 100 East Ridge, Ridgefield, CT 06877-4606 USA. BE SURE THAT YOUR NAME AND ADDRESS ARE CLEARLY PRINTED ON EACH SKETCH, PHOTO AND NOTE YOU SUBMIT. Because of the number of ideas we receive, we can neither acknowledge each one nor return unused material.

Instant relief

Installing the brass eyelets into servo grommets can be a real pain in the fingers. A simple installation tool made from a 6-inch length of 3/32-inch wire and an eyelet provides instant relief. Solder or CA the eyelet about 1 inch from one end, and then make a 90-degree bend at the other end to create a handle. To use the tool, slide a couple of eyelets on the wire and push them into the grommet. No more sore fingers!

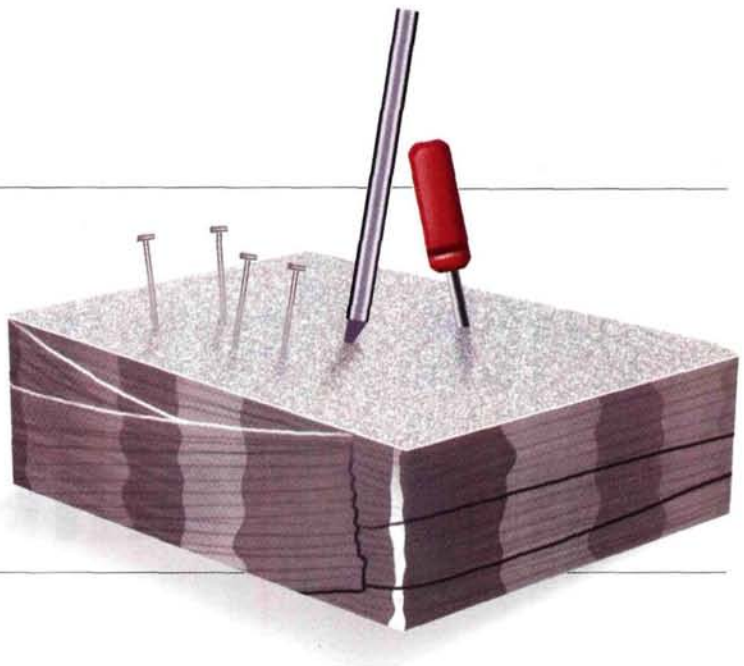
Vernon Coop, Joliet, IL

Master of disguise

Don't like the look of the orange propeller on your park flyer? You can easily change that by using a brown Sharpie marker to color the prop from tip to tip. Don't worry about being too neat; the streaks give it a cool woodgrain appearance.

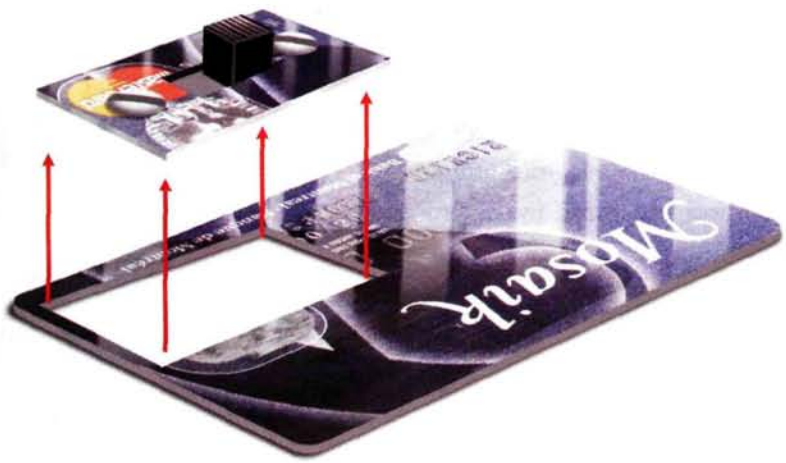
Todd Davis, Cedar Rapids, IA

Easy tool storage



Hobby knives, T-pins and tiny screwdrivers can be difficult to safely store and retrieve on a busy workbench; anyone who has ever had a sharp knife roll off the workbench can attest to this. Here's an easy way to make your work area safer and more organized. The next time you come across a chunk of packing Styrofoam, cut off a piece that's about 2x5x5 inches. Wrap the outside edges of the block with duct or masking tape to prevent them from crumbling. Your "pin cushion" is now ready for use.

John Stewart, Jamul, CA



E-Z reinforcements

Plastic credit and membership cards are very tough and durable. (Ever try to break one?) This makes them useful for making on/off switchplate bezels, odd-shaped washers and wing hold-down reinforcements. Simply score the plastic to the size and shape needed, snap the excess plastic off on the score line and drill any necessary holes. Lightly sand the edges to smooth them, and the part will be ready to use.

Joe De Masi, Redwood City, CA

PILOT PROJECTS

SEND IN YOUR SNAPSHOTS. *Model Airplane News* is your magazine and, as always, we encourage reader participation. In "Pilot Projects," we feature pictures from you—our readers. Both color slides and color prints are acceptable, but please do not send digital printouts or Polaroid prints. Emailed submissions must be at least 300dpi. We receive so many photographs that we are unable to return them. All photos used in this section will be eligible for a grand prize of $500, to be awarded at the end of the year. The winner will be chosen from all entries published, so get a photo or two, plus a brief description, and send them in! Send those pictures to "Pilot Projects," *Model Airplane News*, 100 East Ridge, Ridgefield, CT 06877-4606 USA.

Short Sunderland Mk III

Robert B. Slaton Sr.
Independence, MO

Quad power! Robert scratch-built this WW II flying boat from Palmer Plans and exhibited it at the Toledo RC Expo earlier this year. The 1/12-scale model has a 112-inch wingspan, weighs 40 pounds, features navigation, cabin and landing lights and is powered by four Evolution engines. The plane took more than 1,500 hours to build, and it's truly a standout.

Spacewalker

Carl Schurenberg
West Chester, OH

Carl built this 1/3-scale Spacewalker from Sig's kit. Its plywood ribs with lightening holes, box spar with laminated spruce caps, detachable wing panels and open fuselage framework are all copied from the full-size Spacewalker. Carl's model has a 104-inch wingspan, is 72 inches long, weighs 20 pounds and is powered by a Zenoah G-38 gas engine. He says, "With ultraefficient, gas-sipping engines, cross-country machines dominate the homebuilt market today, so it's refreshing to see a plane designed solely for the pleasure of flight."

Fokker Dr.I Triplane

Darren Gibson
Eau Claire, WI

Darren's gorgeous red Fokker is by Balsa USA. It gets its juice from a Zenoah G-26 engine, uses radio gear from Futaba and Hitec and features a Super Smoke Pumper from B&B Specialties. The plane is covered with Solartex and is "flown" by a pilot from MGA Enterprises.

Peashooter

Carl Malta
Jamestown, NY

Carl admired this giant-scale beauty designed by Henry Haffke when it was featured in *Model Airplane News* in 1995, so he finally ordered the plans and got busy. His Peashooter has an 82-inch wingspan, is 64 inches long and weighs 10 pounds. He powers it with an O.S. Max 90 2-stroker, and he used Coverite's 21st Century fabric, MonoKote trim and paint to finish it in the same color scheme as Henry used. Says Carl, "It flies like a dream; thanks, Henry, for such a great design!"

1/5-scale Spitfire

Robert Shadroui

Clearwater, FL

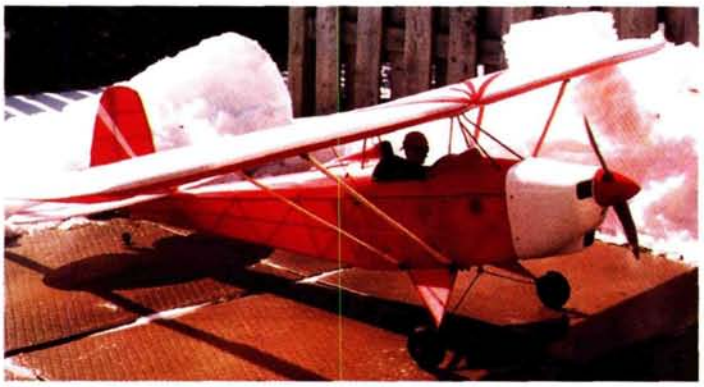
Bob writes, "This is my new 1/5-scale Spitfire built from a Yellow Aircraft kit. It has a 90-inch wingspan and weighs 22 pounds. The plane is equipped with Yellow Aircraft retracts and spinner and a Nelson automatic onboard glow system. It's powered by a Moki 1.8 engine and controlled by Airtronics radio gear. The camouflage paint was applied using a fine foam roller, and it worked quite well!"

B-25

Gene Baguley

Apple Valley, CA

Tom Baguley sent us this photo of his dad Gene's "new baby," a North American B-25 that he scratch-built using Royal Plans. Weighing 11 pounds and with a nearly 71-inch wingspan, the model replicates a PBJ-1H Navy version. Finished in Coverite and painted with 21st Century paints over planked balsa, this beauty features handmade guns, pilot and tail gunner.



Pober Pixie

William Featherstone

St. Catharines, Ontario, Canada

Bill, a longtime reader, tells us that his Pober Pixie was built from *Model Airplane News* plans. It was a winter building project that he greatly enjoyed, due in no small part to several unusual construction methods, e.g., a sectional fuselage, laminations and a unique parasol design. A believer in building light, Bill covered his model in Litespan; it's powered by an O.S. .52 4-stroke. He adds, "The last time I sent a photo to your magazine was in 1942 or '43—quite a thrill for a 12-year-old to have it published! The model was a 'Commando,' over-powered by an O&R 23 (ignition). I still fly an RC version of the plane." Many thanks for writing, Bill, and welcome back to these pages!

Sopwith Camel

Walter Thyng, Huntley, IL

Walter sent in these photos of his VK Sopwith Camel available from Proctor Enterprises. The plane has a 59-inch wingspan, weighs 8 pounds and is powered by an AstroFlight 25 motor swinging an MA Scimitar 16x10 prop on 20, P3000 NiMHs. The Camel has full flying wires, and the pull-pull control cables exit in the scale locations. Not visible are the switches that are disguised as the machine-gun arming levers. Walter explains, "I'm sending you these photos because I finished the plane according to Roy Vaillancourt's instructions on painting with latex in the November '03 issue of *Model Airplane News*. This is the first plane I've finished completely with paint since I discovered MonoKote in 1969! My thanks to Roy for adding such a great new tool to my modeling arsenal."

AIR SCOOP

by the Model Airplane News *crew*

NEW PRODUCTS hit the model airplane market all the time, so here's the inside source for what's hot and where you can get it. For every issue, we sift through product announcements, show reports, rumors and prototypes to let you in on the best and the latest. Remember, you saw it here first!

CARL GOLDBERG

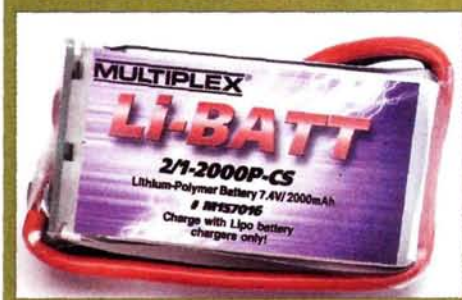
EAGLE 400 & TIGER 400 ARFS

Take your pick! The folks at Carl Goldberg have two new electric designs to choose from: the stable, high-wing Eagle trainer and the highly aerobatic, low-wing Tiger! Each comes assembled out of all-wood, laser-cut parts and with a geared Speed 400 motor and complete hardware packages that include prop, spinner and wheels. The Tiger 400 has a 39-inch wingspan; the Eagle 400's is 38 inches. Each requires a 4-channel radio with 4 microservos, and each costs $109.99.

Carl Goldberg; distributed by Great Planes Model Distributors (217) 398-6300; (800) 682-8948; greatplanes.com.

MULTIPLEX

LI-BATT LITHIUM-POLYMER BATTERIES



The folks at Multiplex are excited to release their new line of Li-poly batteries, with 19 packs and cells to choose from. They range from single 145mAh cells for indoor models up to 4000mAh packs for large-flying-field planes. The 2000mAh pack shown is capable of a 12.5C constant-rate discharge (25 amps) and a 15C burst discharge (30 amps), and it's ideal for use with any high-performance, 400-size brushless motor. Prices range from $8.49 to $194, depending on size and configuration.

Multiplex; distributed by Hitec RCD (858) 748-6948; multiplexusa.com.

GREAT PLANES MODEL MFG.

Patriot XL

The popular Patriot is now available supersized! The original model was well known as a fast, fun-to-fly alternative to ducted-fan jets, and the Patriot XL continues that tradition. It's also easier to assemble because it features fewer and simpler wood parts and more molded parts. Fixed landing gear is included (retracts optional!), and the Patriot is designed for dual aileron and elevator servos for precise, authoritative control. The included cowl will enclose any .60 to .91 engine (with a .91, this jet is blindingly fast and is capable of superquick maneuvers!). The Patriot XL requires a 6-channel radio and at least 6 servos. Specs: wingspan—55 in.; wing area—742 sq. in.; weight—8 to 8.5 lb.; wing loading—25 to 27 oz./sq. ft.; length—59.5 in. The Patriot XL kit costs $159.99.

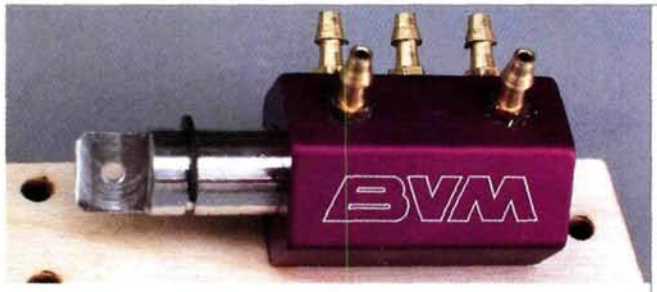
Great Planes Model Mfg. (217) 398-6300; (800) 682-8948; greatplanes.com.

E-FLITE

GYPSY PARK EP FLYER

From its scalloped trailing edge to its nostalgic high-wing design, the Gypsy EP Park Flyer is designed with the laid-back sport flyer in mind. The Gypsy features lightweight wood construction and is covered in UltraCote. A geared 370 motor and propeller are included, and assembly takes only a few hours. Because the Gypsy uses a classic high-wing design with generous wing area, its flight characteristics are exceptionally gentle. This combined with its compact size allows it to be flown virtually anywhere. Specs: wingspan—35.25 in.; length—27.5 in.; wing area—266 sq. in.; weight—13.5 to 14.5 oz. The Gypsy needs a 4-channel radio with two submicroservos. Price: $79.99.

E-flite; distributed by Horizon Hobby Inc. (217) 352-1913; horizonhobby.com.



BOB VIOLETT MODELS

HI-FLOW RETRACT VALVE

When you have retracts in your plane, you need to know that they'll work perfectly every time. This new offering from BVM facilitates more positive actuation of your retractable landing gear—especially when they're fitted with ¾- to 1-inch-diameter cylinders. Attractively anodized in BVM's signature purple (violet!), the Hi-Flow Valve actuates easily with most miniservos and comes with a plywood mounting tab and screws. It is standard with all BVM landing-gear air-installation packages.

Bob Violett Models (BVM), (407) 327-6333; bvmjets.com.

HIROBO

PAINTED TOW COBRA AND SUPER COBRA

Now you can buy Hirobo's Tow Cobra (shown above) and Super Cobra with bodies that have been beautifully detailed with fuelproof paint. The Super Cobra AH-1W is a scaled-down version of the heli used by the U.S. Marines and has an S-60II frame for simple installation. It also uses many of Hirobo's option parts, including a stainless-steel pipe drive with a 130-degree angled transmission. The Tow Cobra is a copy of the U.S. Army's attack helicopter and has precisely replicated Tow launcher, gun sight and detailed cockpit. This kit has recently been improved to fly even more like the real thing. The painted Super Cobra and Tow Cobra each cost $2,600; the unpainted versions are $1,950.

Hirobo; distributed by MRC (732) 225-6360; modelrectifier.com.

KLASS KOTE

2-PART EPOXY FINISHING SYSTEM

Many scale modelers cried out loud when the old K&B SuperPoxy and Petit HobbyPoxy paints were taken off the market by the EPA. Well, the Klass Kote system is not only a perfect replacement for these old epoxy paints, but it can also be used freely in combination with leftover HobbyPoxy and SuperPoxy materials (but test before applying to a model). Klass Kote is not compatible with UltraPoxy paints. Klass Kote works ideally with conventional air-atomizing spray equipment as well as HVLP and airless equipment. It can also be applied with a brush or a foam roller. Once the components are mixed and reduced, the paint covers just like any other conventional finishing material, and in most weather conditions. A pint of all of the epoxy colors, clear, primers and catalysts costs $19.95; a ½ pint is $12.95; and a quart is $29.95. A pint of epoxy reducer is $7.95; a ½ pint is $5.95; a quart is $9.95.

Klass Kote (612) 243-1234; klasskote.com.

MODEL TECH

FUN FLY 90S

This large, freestyle, 3D ARF is looking for a pilot who isn't afraid to try new things. Crazy aerobatics and fun-fly routines are a must! With laser-cut parts for a precise factory fit, genuine MonoKote covering, pull-pull rudder control and aluminum gear, the Fun Fly 90S may be the best-quality plane that Model Tech has ever released—and because Model Tech is well known for its first-rate planes, that's saying a lot! The model also features a short tail for much quicker snaps and spins. We can't wait to get our hands on this one. Specs: wingspan—61 in.; wing area—1,100 sq. in.; length—58 in.; weight—6.75 to 7.25 lb.; engine req'd—60 to .91 2-stroke; radio req'd—4-channel with 5 high-torque servos. The Fun Fly 90S costs $199.99.

Model Tech; distributed exclusively by Global Hobby Distributors; (714) 963-0329; globalhobby.com.

ELECTRIFLY

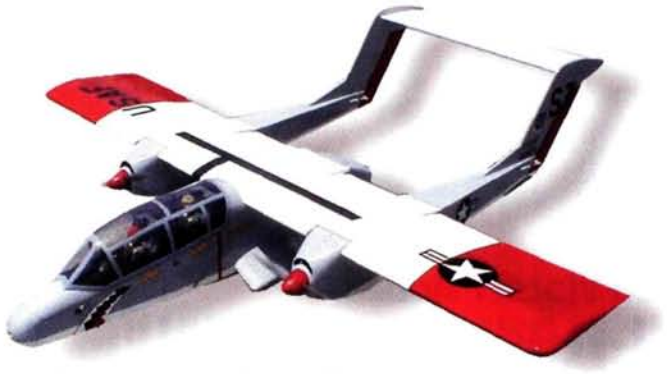
MINI PIPER CUB

Who doesn't love a Cub? This 41-inch-span classic comes completely built and covered, so it's ready for small-field flying in just 4 to 6 hours. It even comes with a geared 280 motor and prop; you'll only need to add a 3-channel radio with two microservos. An easy-access hatch and band-on wing allow easy access to the onboard radio gear for maintenance and battery-pack swaps, and the Mini Cub's large rudder and elevator allow smooth, slow flying in smaller airspaces with simple, 3-channel radio control. The Mini Piper Cub costs just $99.99.
ElectriFly; distributed by Great Planes Model Distributors (217) 398-6300; (800) 682-8948; electrify.com.

KLEIN AVIATIK

AMERICAN BEAUTY P-51

This electric-powered Mustang lives up to its name! But it's no hangar queen: the full-house plane is designed to perform terrific aerobatics, including snap maneuvers. The built-up model comes fully covered and with self-stick decals. Specs: wingspan—30.5 in.; length—30 in.; wing area—230 sq. in.; weight—29 oz., wing loading—18 oz./sq. ft. Distributor Hobby Lobby Intl. notes that the model has endless climb performance when powered with an AXI 2808/16 external rotor brushless motor. The American Beauty P-51 costs just $99.
Klein Aviatik; distributed by Hobby Lobby (615) 373-1444; hobby-lobby.com.



SCALETECH PRODUCTS

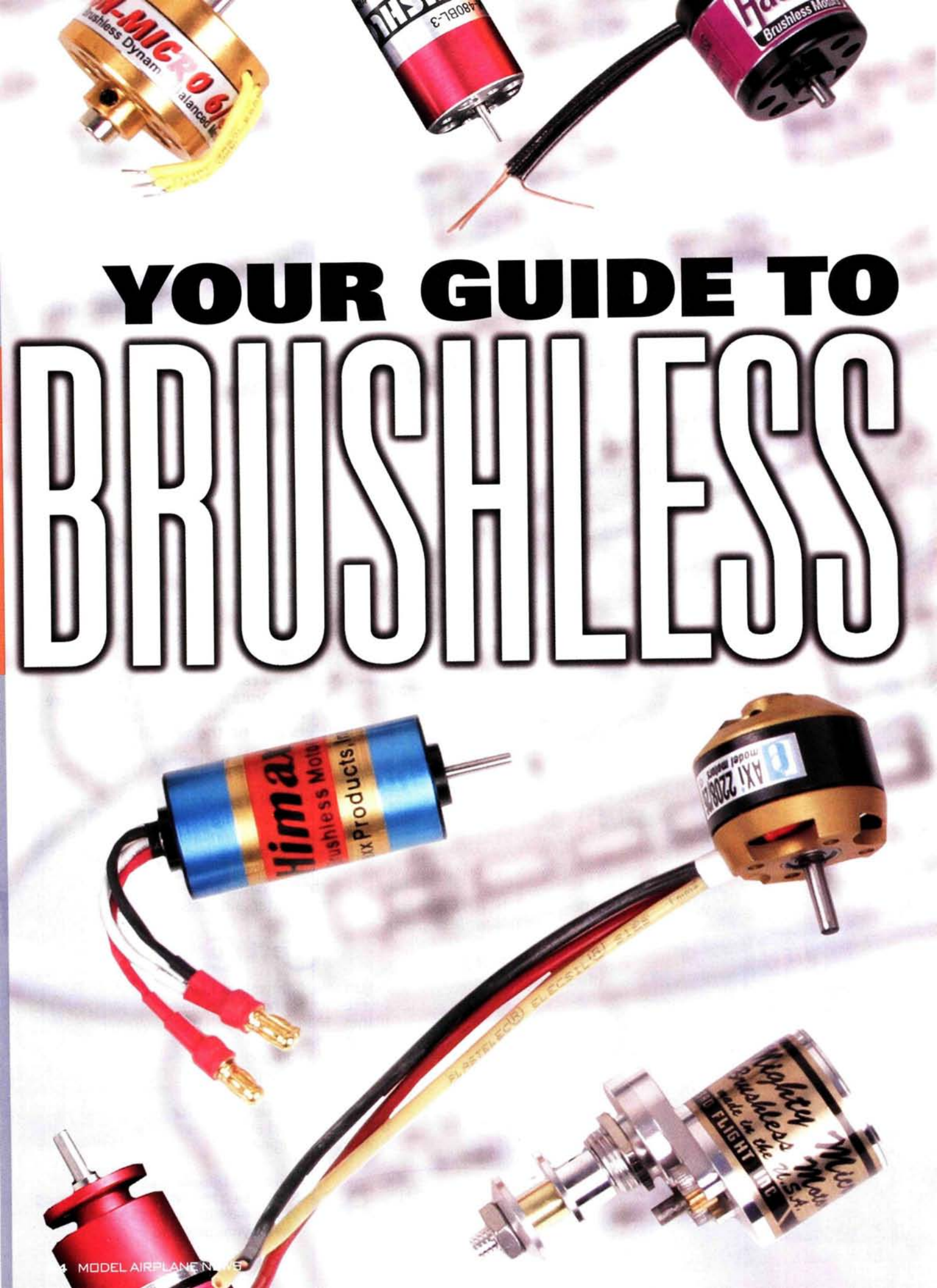
GIANT OV-10 ARF BRONCO

The second in ScaleTech's new "Prestige Series" line, this giant-scale ARF was developed from the original Rich Uravitch design. If you're looking for a first multi-engine model, you're in luck because this plane has been thoroughly flight-tested to ensure a high degree of success. The Bronco comes with all required hardware, including engine mounts, fuel tanks, wheels, spinners and control linkages—even a ready-to-install servo harness that's made specifically for it! All airframe components are covered with iron-on film, and the canopy framing and fiberglass engine cowls and fuselage endcaps are painted to match. The provided set of self-adhesive U.S. Air Force markings is the icing on the cake. The model is provided with rugged, fixed gear, but provision for fitting air-operated retracts is already built in. Specs: wingspan—80 in.; wing area—1,215 sq. in.; length—78.5 in.; weight—15 to 17 lb.; engines req'd—two .46 to .61 2-strokes; radio req'd—5-channel (6 w/retracts). The OV-10 Bronco costs $439.95.
ScaleTech Products; distributed by Hobby Hangar (321) 727-8227; hobbyhangar.com.

HANGAR 9 ULTRACOTE

MAGIC COLORS

Want to create an out-of-the-ordinary scheme? UltraCote jazzes up your covering palette with three brand-new colors: Magic Violet, Magic Red-Gold and Magic Cyno-Violet—all guaranteed to turn heads at the field. Their prismatic effect in sunlight is, well ... magic! All offer superior color adhesion, and each roll costs $32.99.
Hangar 9 UltraCote; distributed by Horizon Hobby Inc. (217) 352-1913; horizonhobby.com.

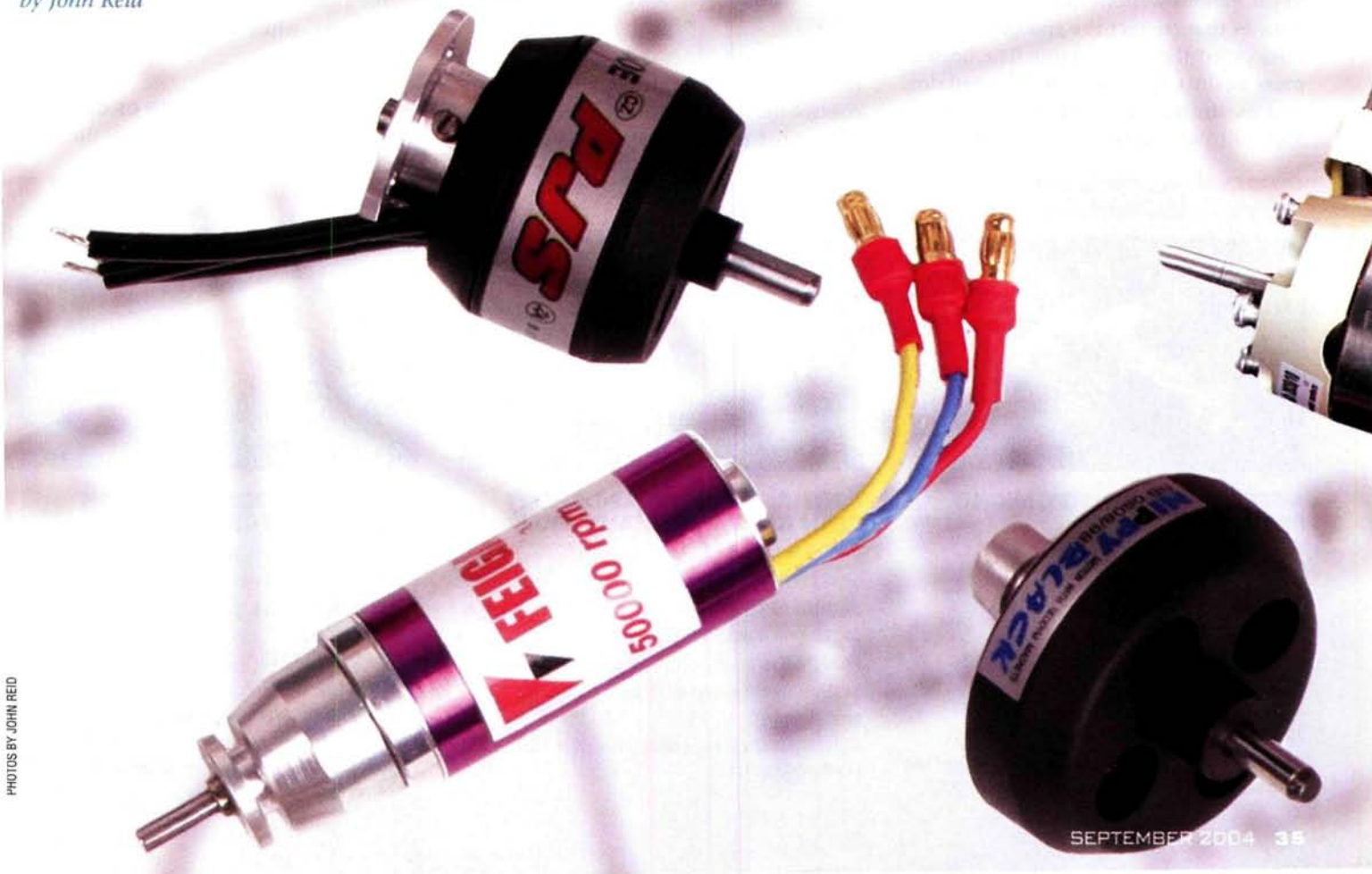

YOUR GUIDE TO
BRUSHLESS

Step up to more power and efficiency!

MOTORS

Over the past few years, electric flight has found its way into mainstream RC, and one of the key reasons for this is the brushless motor. At almost any electric flying field, the plane that performs with the most speed and agility probably has a brushless motor in its nose. Simply replacing a brushed motor with a brushless motor will increase the performance of just about any electric plane. But are these motors really worth the cost? Do they really perform? Let's look closely at what brushless motors have to offer and how they compare with their brushed counterparts.

by John Reid



PHOTOS BY JOHN REID

YOUR GUIDE TO BRUSHLESS MOTORS

BRUSHLESS VERSUS BRUSHED

Brushless motors can be described as inside-out versions of brushed motors. The two types of motors may look a little different, but the primary distinction between them is the method in which electricity flows into them and how it is converted into motion.

Brushed motors are rather simple devices that have a wire-wrapped armature that spins inside two magnets held within a metal can. The armature has several sections, each of which has copper wire wrapped around it. When each section is energized, it creates a magnetic field that pushes or pulls against the fixed magnets, and this spins the armature.

Hobby Lobby AXI 2208/20

Brushed motors transfer the electricity to the various sections of the armature via brushes that contact the end of the armature, called the commutator. The brushes press against the spinning commutator, and as the armature spins, current is applied to the windings one section at a time. As the armature rotates, a new section of the commutator comes into contact with the brushes and energizes the next section of armature windings, basically switching current from one armature section to the next over and over again.

This method of energy transfer works quite well—up to a point. As we demand more and more power from our motors, the brushes begin to resist the current and place a mechanical drag on the armature. This drag also creates a heat buildup that reduces the motor's efficiency.

Enter the brushless motor. Brushless motors have the windings built into their motor cans' inner structure (stator), and the magnets are permanently attached to the armature (rotor). Instead of using brushes and a commutator to transfer and switch the current, brushless motors use a special speed controller. These sophisticated electronic speed controllers regulate and control the current that energizes the various stator fields in rapid succession to cause the armature shaft to spin. Brushless motors are more efficient because they generate less heat and don't produce any mechanical brush friction.

Dymond Modelsports USA Ltd. Typhoon-Micro 6/3-D

MPI Himax 4200

WINDS AND TURNS

"Turns" are the number of times wire has been wrapped around the armature, or stator. As a general rule, the fewer the turns, the faster the armature rotates. "Winds" are the number of strands in the armature wire, e.g., single, double, triple, etc. A higher number of winds offers better low-end torque, while fewer winds offer more top-end rpm.

BATTERIES AND NUMBER OF CELLS

Brushless and brushed motors use the same

D = DIAMETER; L = LENGTH; W = WEIGHT

ASTROFLIGHT MIGHTY MICRO 010 GEARED

D: 0.98 in., **L:** 1.5 in. **W:** 1.8 oz.
SHAFT DIAMETER: 1/8 in.
NUMBER OF CELLS: 7 to 10 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Astro 10 amp
PROP: 8x6 to 10x7
SUITABLE FOR: park flyers
PRICE: $114.95
COMMENTS: includes a very strong 3.3:1 gearbox and comes with a sensorless speed control for $149.95.

CERMARK FEIGAO 130 SHORT WITH 3.2:1 PLANETARY GEAR

D: 0.79 in., **L:** 1.18 in., **W:** 1.73 oz.
SHAFT DIAMETER: 4mm
NUMBER OF CELLS: 6 to 12 Ni-Cd/NiMH; 2 to 4 Li-poly
SPEED CONTROL: 15 to 25 amp
PROP: 9x4 to 10x4.7
SUITABLE FOR: planes to 15 oz.
PRICE: $99.90
COMMENTS: includes a factory-installed 3.2:1 planetary gearbox.

CERMARK FEIGAO 130 WITH 3.2:1 PLANETARY GEAR

D: 0.79 in., **L:** 1.57 in., **W:** 2.12 oz.
SHAFT DIAMETER: 4mm
NUMBER OF CELLS: 6 to 12 Ni-Cd/NiMH; 2 to 4 Li-poly
SPEED CONTROL: 15 to 25 amp
PROP: 9x4 to 10x4.7
SUITABLE FOR: planes to 15 oz.
PRICE: $97.90
COMMENTS: includes a factory-installed 3.2:1 planetary gearbox.

Large Brushless Motors

Brushless motors aren't just for smaller electric planes; several manufacturers produce big brushless motors that make it possible to convert larger gas or glow planes to electric power. Many airplane manufacturers also encourage the use of electric power and include conversion instructions in their instruction manuals. These planes fly equally well with either power system. Probably the most significant modifications needed to power glow models with big brushless motors are converting the engine compartment and engine mounts to install the brushless motor and making enough room inside the fuselage to accommodate the large battery packs needed for power.

Larger motors are capable of swinging very large props and producing a surprising amount of thrust, especially when they are geared appropriately. Larger brushless motors also require a significant amount of amp draw and voltage.

Because electric power is so quiet, you must be especially careful when working around large electric-powered aircraft. All ESCs have a built-in safety to prevent the motors from turning on when the battery is plugged in. This is called "arming the motor" and usually requires the throttle to be set to the idle position before the motor will function. Once the motor is armed, the ESC will give an audible warning beep.

Manufacturers such as AstroFlight, Hacker, Cermark, ICARE, AXI and Phasor all produce larger brushless motors for use in big planes. Just remember to be cautious whenever you use electricity for power. Be alert and stay safe!

DYMOND MODELSPORTS USA LTD. TYPHOON-MICRO 6/20

D: 1.125 in., **L:** 0.95 in.; **W:** 1.52 oz.
SHAFT DIAMETER: 3.175mm
NUMBER OF CELLS: 6 to 10 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Tsunami-10
PROP: 5x5 to 9x4
SUITABLE FOR: planes from 14 to 24.5 oz.
PRICE: $59
COMMENTS: this outrunner has an excellent power-to-weight ratio and is capable of turning larger props without a gearbox.

DYMOND MODELSPORTS USA LTD. TYPHOON-MICRO 6/3-D

D: 1.125 in., **L:** 0.95 in.; **W:** 1.52 oz.
SHAFT DIAMETER: 3.175mm
NUMBER OF CELLS: 6 to 10 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Tsunami-10
PROP: 5x5 to 9x4
SUITABLE FOR: planes from 14 to 24.5 oz.
PRICE: $59
COMMENTS: the Typhoon-Micro 6/3-D outrunner has more power than the 6/20. Though not intended for heavier planes, the 6/3-D will provide the extra power needed for High Alpha maneuvers (3D).

HACKER BABY 200-10-PRO-S

D: 0.9 in., **L:** 1 in., **W:** 1 oz.
SHAFT DIAMETER: 3mm
NUMBER OF CELLS: 7 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Master 4-B-Flight
PROP: 7x3.8 to 9x4.7 slow-fly
SUITABLE FOR: lightweight indoor planes
PRICE: $119
COMMENTS: this outrunner is the newest release from Hacker and is specially designed for lightweight indoor model aircraft.

upgrading to brushless

Brushless motors don't require any special installation; in fact, some brushless motors are designed to fit into brushed motor mounts. The main concern when mounting a brushless motor is that it produces more torque than a brushed motor. This means that when you mount a brushless motor in a plane that was designed for (or originally equipped with) a brushed motor, you may need to beef up the motor mount. This can be as simple as adding additional plywood support to it. This is especially important when working with larger, stronger brushless motors.

In many situations, however, a brushless motor will be smaller than the brushed motor it replaces. This is because the smaller brushless motors are more efficient and produce significantly more power when compared with brushed motors. Motor mounts or gearboxes for larger brushed motors can be adapted to the smaller brushless motor by simply adding a spacer around the brushless motor's case.

A good example of this is when using a GWS gearbox with a brushless motor. The Himax brushless motor provides a significant power increase, but its diameter is smaller than that of the brushed GWS motor. A simple solution is to use an O-ring around the case of the Himax motor, and then slide the motor into the gearbox and fasten it with the GWS screws. The O-ring automatically centers the Himax motor in the gearbox, making this a simple conversion.

batteries (Ni-Cd, NiMH, or Li-poly). But even with exactly the same battery packs, you will find that because brushless motors are more efficient, flying time and power will increase compared with that provided by brushed motors. Generally speaking, flight duration increases when larger-capacity batteries are used, while power and torque increase when voltage is boosted (by adding more cells). Check your manufacturer's recommendations for the maximum number of cells your motor can handle.

Hobby Lobby MP Jet AC 25/25-26 Mk2

HOW DO THEY STACK UP?

Let's see how brushed and brushless motors measure up in five categories: power, cost, equipment, break-in and cleaning/maintenance.

• **Power.** Brushless motors have a huge advantage in power and efficiency over brushed motors of comparable size and

continued on page 42

HACKER B20-26S

D: 0.9 in., **L:** 1.4 in., **W:** 1.4 oz.
SHAFT DIAMETER: 2.3mm
NUMBER OF CELLS: 6 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Master 08-B-Flight
PROP: 4- to 5-in.
SUITABLE FOR: planes up to 11 oz.
PRICE: $109
COMMENTS: this motor is a high-performance upgrade for a 280-powered model.

HACKER B20-26S+4:1

D: 0.75 in., **L:** 1.9 in., **W:** 2.4 oz.
SHAFT DIAMETER: 3mm
NUMBER OF CELLS: 6 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Master 08-B-Flight
PROP: 10x7
SUITABLE FOR: planes up to 18 oz.
PRICE: $139
COMMENTS: this motor includes a 4.4:1 gear drive.

HOBBY LOBBY AC 28/7-30D OUTRUNNER BRUSHLESS

D: 1⅜ in., **L:** 1 5/16 in., **W:** 2 oz.
SHAFT DIAMETER: 3mm
NUMBER OF CELLS: 6 to 9 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Jeti 18A brushless
PROP: 7x3 to 10x4.7
SUITABLE FOR: aerobatic planes to 18 oz.; sailplanes to 27 oz.
PRICE: $59
COMMENTS: this tiny outrunner brushless motor has an improved power performance and is more efficient than other brushless motors, and that translates to longer, more powerful flights.

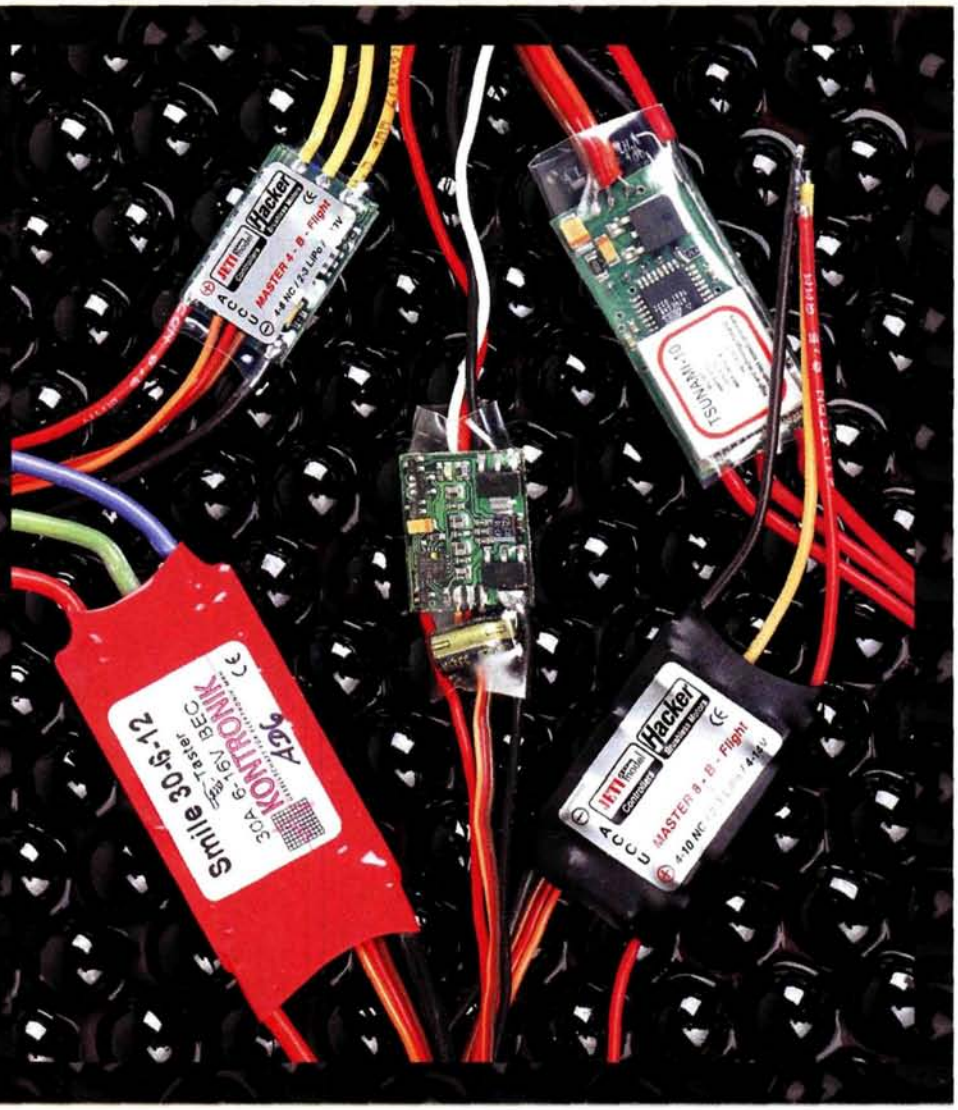
Brushless Speed Controllers

Brushless motors require special ESCs that have three wire leads that are connected to the motor. A brushed-motor ESC has only two wire leads because it has to regulate only the amount of current supplied to the motor, which in turn increases and decreases motor rpm. Brushless ESCs control the current electronically according to the rotor-position feedback from the motor. The switching of the winding polarity (commutation) is done entirely by the ESC.

Sensorless ESCs don't require rotor-position feedback from the motor and must be used to run sensorless motors; however, sensorless ESCs can also be used with brushless motors with sensors. Brushless ESCs cannot be used with brushed motors.

Because both the sensorless and sensored ESCs electronically switch the magnetic fields inside the motor, they generate significant heat and require some cooling airflow during normal operation.

Motor-rotation direction is controlled by the ESC. Reversing its direction is just a simple matter of switching any two of the three wires from the ESC. Because of this, it is often a good idea to check the rotation of your motor on the bench before you permanently solder the motor leads to the ESC leads. Gold-stick power plugs (or similar connectors) can be used to connect the motor leads to the ESC so you can reverse the motor's direction at any time.



HOBBY LOBBY AXI 2208/20

D: 1⅜ in., **L:** 1⅜ in., **W:** 2.75 oz.
SHAFT DIAMETER: 3mm
NUMBER OF CELLS: 4 to 8 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Jeti 30 amp
PROP: 9x5 to 10x6
SUITABLE FOR: planes up to 60 oz.
PRICE: $89
COMMENTS: has extremely high torque because of the external rotor's large diameter.

HOBBY LOBBY PHASOR 15/3

D: 1.42 in., **L:** 1.46 in., **W:** 4.8 oz.
SHAFT DIAMETER: 5mm
NUMBER OF CELLS: 6 or 7 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Jeti Advance 30A brushless
PROP: 7x4 to 8x4
SUITABLE FOR: planes to 45 oz.
PRICE: $94
COMMENTS: these extremely powerful motors are intended for direct drive to the propeller instead of using a gear reduction.

HOBBY LOBBY MP JET AC 25/25-26 MK2

D: 0.98 in., **L:** 0.98 in. **W:** 1.48 oz.
SHAFT DIAMETER: 2mm
NUMBER OF CELLS: 6 to 8 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Jeti JESA18
PROP: 7x3 to 9x6 with 4:1 gearbox
SUITABLE FOR: planes from 14 to 24.5 oz.
PRICE: $58.90 (w/gearbox)
COMMENTS: the MP Jet line of motors provides great performance and durability. This motor works best with a 3:1 or 4:1 gearbox.

Motor glossary

ARMATURE: the rotating part of a brushed motor that consists of copper wire wound around an iron core.

BRUSH: a sliding connection completing a circuit between a fixed and a moving conductor; used in the brushed motor to transfer current from the source to the commutator on the armature.

CAN: the outside case of a brushed or brushless motor. The words "can motor" often refer to an inexpensive brushed motor.

COGGING: refers to how rough the rotation and motion of the motor are. The lower the motor's cogging, the smoother the rotation. The higher the motor's cogging, the jerkier its rotation. A low-cogging motor results in smoother propulsion.

COMMUTATOR: the cylindrical section at the end of the armature that comes into contact with the brushes. It switches current flow to the various armature sections.

ENDBELL: the endcap on the motor housing that holds everything in place inside the can.

KV/KB: this number is the motor voltage constant expressed in rpm/volts. It indicates how fast the motor will turn at a given voltage

KT: this number represents the motor's torque constant expressed in ounce-inches of torque per amp current, or the amount of torque a motor would produce per amp of current draw.

SHAFT: the center armature/rod that actually spins, transferring the motor power to the gears or prop.

STATOR (ARMATURE): the stationary part of a motor, generally wrapped with copper wire, in which a rotor turns.

TURNS: the number of times wire is wrapped around the armature or stator. As a rule, the fewer turns, the faster the rotation of the armature.

WINDS: the number of strands in the armature wire, e.g., single, double, triple, etc. More winds offer better torque; fewer winds offer more top-end rpm.

Here are some symbol definitions often associated with brushed and brushless motors:
Eff = Efficiency
I = Current
Iemax= Most efficient current
Inl = No load current
J = Torque (oz.-in./A)
Pi = Power input (watts)
Po = Mechanical power output (watts)
Rm = Terminal resistance
Rpm = Revolutions per minute
V = Voltage

HOBBY LOBBY PJS 3-D 550E EXTERNAL ROTOR BRUSHLESS

D: 1¼ in., **L:** 1½ in., **W:** 1.76 oz.
SHAFT DIAMETER: 4mm
NUMBER OF CELLS: 6 to 8 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: Jeti Advance 18-3P
PROP: 10x4.7 to 11x4.7
SUITABLE FOR: planes up to 18 oz.
PRICE: $99
COMMENTS: this is a high-torque motor designed especially for aerobatic planes up to 18 ounces. The motor produces more than 19 ounces of thrust.

HOBBY LOBBY MEGA MOTOR

D: 1.1 in., **L:** 1.18 in., **W:** 2.68 oz.
SHAFT DIAMETER: 3mm
NUMBER OF CELLS: 8 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Jeti JES 30-3P
PROP: 5x5 to 11x4.7 (using gearbox)
SUITABLE FOR: planes up to 32 oz.
PRICE: $89.90
COMMENTS: this motor is a direct replacement for Speed 400 and 480 brushed motors. They have greater efficiency and much more power.

HOBBY LOBBY NIPPY BLACK EXTERNAL ROTOR

D: 1⅝ in., **L:** 1½ in., **W:** 1.41 oz.
SHAFT DIAMETER: 4mm
NUMBER OF CELLS: 6 to 8 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: Jeti 08-3P
PROP: 8x6 to 11x5.5
SUITABLE FOR: planes up to 15.87 oz.
PRICE: $79
COMMENTS: this External Rotor motor is designed to be a direct drive and is capable of turning a larger prop.

ICARE PLETTENBERG FREESTYLE 24

D: 1.5 in., **L:** 1 in., **W:** 2.75 oz.
SHAFT DIAMETER: 5mm
NUMBER OF CELLS: 6 to 9 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL:15 amp
PROP: 8x6 to 10x4.7
SUITABLE FOR: park flyers
PRICE: $149
COMMENTS: this motor offers great torque, and because of improved winding techniques, it has better overall efficiency.

KONTRONIK FUN400-36 GEARED

D: 1.1 in., **L:** 2.5 in., **W:** 3.9 oz.
SHAFT DIAMETER: 5mm
NUMBER OF CELLS: 6 to 14 Ni-Cd/NiMH; 3 to 4 Li-poly
SPEED CONTROL: Smile 40-6-12
PROP: 11x4.7
SUITABLE FOR: small, fast planes
PRICE: $229.99
COMMENTS: the motor includes a 4.2:1 gear drive.

weight. For example, the brushless Himax 4100 is very close in size and weight to a standard Speed 280 brushed

AstroFlight Mighty Micro 010 geared

motor; however, it produces power that is comparable to a larger Speed 480 motor. Advantage: brushless.

• **Cost.** Brushless motors cost significantly more than brushed motors, but their prices continue to decrease as more manufacturers jump on the brushless bandwagon. Even with fierce competition driving down brushless-motor prices, however, don't expect them ever to be cheaper than brushed motors. The good news is that brushless motors have a much longer life expectancy than brushed motors. Advantage: brushed.

• **Equipment.** Brushless motors require special ESCs that are designed specifically for brushless motor applications, and these also cost more than standard brushed-motor ESCs. Advantage: brushed.

• **Break-in.** Brushless motors do not require break-in; brushed motors do. Need I say more?

• **Cleaning/maintenance.** To operate at peak efficiency, brushed motors require maintenance and cleaning. Brushless motors have sealed cases that require no cleaning or maintenance. Advantage: brushless.

Hacker B20-26S+4:1

Electric power is becoming more mainstream in the RC community. With their efficient conversion of electricity to power and increased torque, brushless motors have played an important part in the development of E-flight. Brushless motors offer increased performance and longer flights, and they require little or no maintenance. Is it any wonder that E-flight is one of the fastest growing segments of the RC industry? ✈

Hobby Lobby PJS 3-D 550E External Rotor Brushless

AstroFlight (310) 821-6242; astroflight.com.
Axi; distributed by Hobby Lobby.
Cermark (562) 906-0808; cermark.com.
Dymond Modelsports USA Ltd. (888) 4FUN FLY; (920) 303-1100; rc-dymond.com.
Hacker (480) 726-7519; hackerbrushless.com.
Hobby Lobby Intl. (615) 373-1444; hobby-lobby.com.
ICARE (450) 449-9094; icare-rc.com.
Kontronik; distributed by Great Planes Model Distributors (217) 398-6300; (800) 682-8948; greatplanes.com.
MPI (Maxx Products Intl.) (800) 416-6299; (847) 438-2233; maxxprod.com.
Multiplex; distributed by Hitec RCD (858) 748-6948; hitecrcd.com.
Phasor; distributed by Hobby Lobby.

MPI HIMAX 4100

D: 0.79 in., **L:** 1.26 in., **W:** 1.7 oz.
SHAFT DIAMETER: 2mm
NUMBER OF CELLS: 6 to 10 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: 10 amp
PROP: 9x4 to 10x 4.7 (geared)
SUITABLE FOR: planes 8 to 30 oz.
PRICE: $51.95
COMMENTS: this motor is designed for lightweight, high efficiency, and it is extremely durable.

MPI HIMAX 4200

D: 0.79 in., **L:** 1.68 in., **W:** 2.15 oz.
SHAFT DIAMETER: 2mm
NUMBER OF CELLS: 6 to 10 Ni-Cd/NiMH; 2 to 3 Li-poly
SPEED CONTROL: 15 amp
PROP: 9x4 to 10x4.7 (geared)
SUITABLE FOR: planes from 8 to 30 oz.
PRICE: $59.95
COMMENTS: this motor is designed for lightweight, high efficiency and is extremely durable.

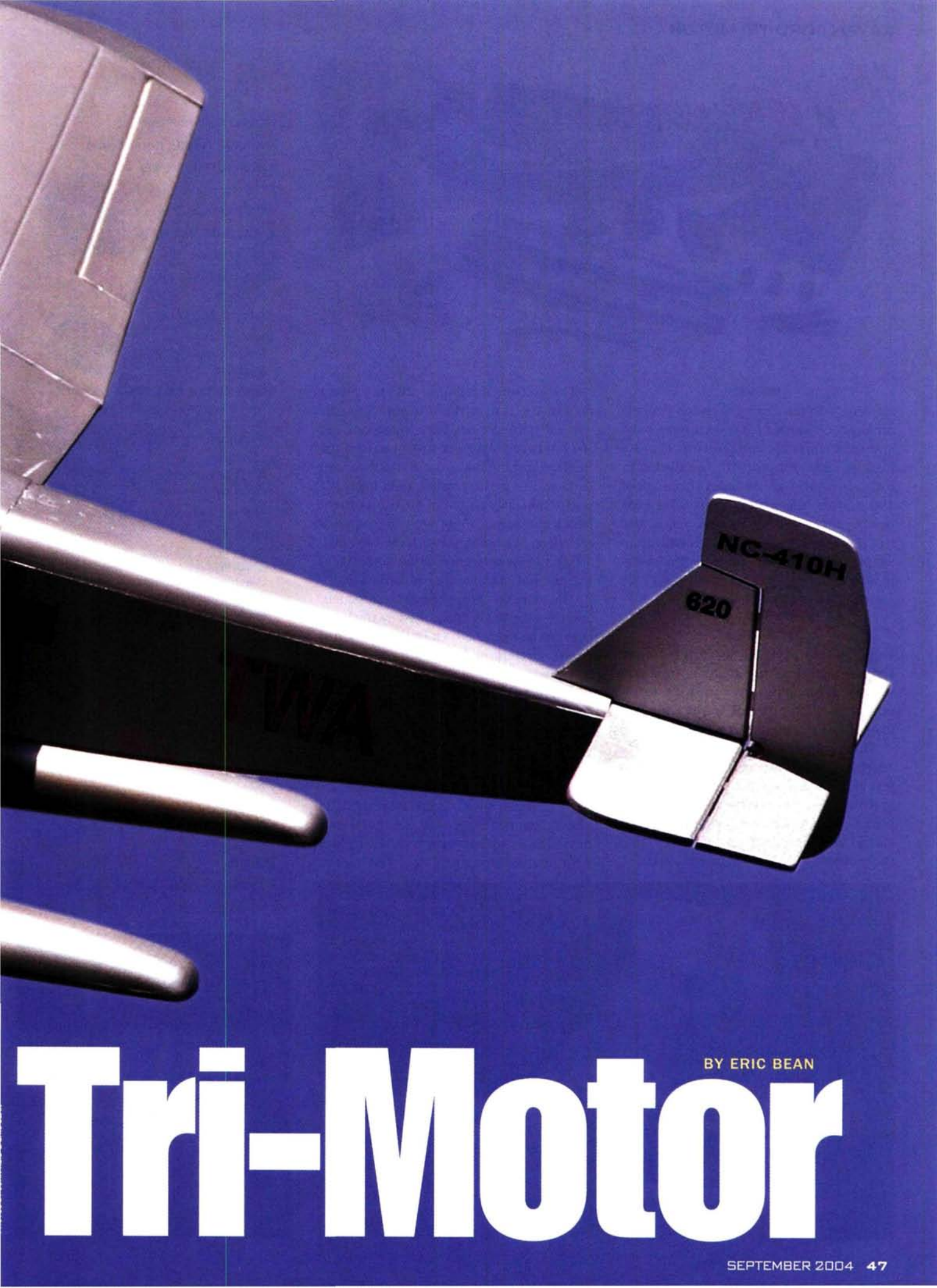
MULTIPLEX PERMAX BL-480

D: 1.25 in., **L:** 1.95 in., **W:** 4.23 oz.
SHAFT DIAMETER: 3.2mm
NUMBER OF CELLS: 6 to 8 Ni-Cd/NiMH; 2 Li-poly
SPEED CONTROL: 30 amp
PROP: 4- to 5-in.
SUITABLE FOR: planes from 12 to 20 oz.
PRICE: $69.99
COMMENTS: this motor is the fastest of the Multiple line and offers incredible rpm and speed. It drops right into a Speed 400 mount because it has a similar bolt pattern.

A famous, all-foam multi-engine transport with floats

KAVAN Ford

Henry Ford had mobilized millions of Americans with his Model T, "Tin Lizzie," from 1909 to 1926, when he saw an opportunity to provide air transportation for the masses. Nicknamed the "Tin Goose," the Ford Trimotor was one of the largest all-metal aircraft produced at that time. The fuselage, wings and tail were manufactured from corrugated aluminum and required much less maintenance than the more common fabric-covered structures of that time. Ford specified three engines to overcome concerns of engine reliability. The Trimotor could maintain level flight with just two motors; the third provided a safety margin should one engine fail. Slightly fewer than 200 Trimotors were built. The most common variant was the 5-AT, which could carry 13 passengers at 90 knots for up to 500 miles. Some Ford Trimotors were fitted with skis or floats.



Tri-Motor

BY ERIC BEAN

specifications

MODEL: Ford Tri-Motor

MANUFACTURER: Kavan GmbH

DISTRIBUTOR: Sig Mfg.

TYPE: foam electric ARF

WINGSPAN: 41.7 in.

WING AREA: 256 sq. in.

WEIGHT: 23 oz.

WING LOADING: 12.9 oz./sq. ft.

MOTORS REQ'D: 3

MOTORS USED: 3 Graupner Speed 280 (included)

RADIO REQ'D: 4-channel with 4 servos (rudder, elevator, throttle, ailerons [2])

RADIO USED: JR XP8103 with Hitec HS55 sub-microservos

PROPS: 5.7x3 APC electric (3)

PRICE: $184.99

FEATURES: lightweight prepainted-foam construction, prehinged control surfaces, control horns come installed; complete hardware package includes 3 Graupner Speed 280 motors, wiring harness, 3 APC props and prop adapters, decals and touchup paint.

COMMENTS: the Kavan Ford Tri-Motor is a fun airplane! It took a little longer to build than I thought it would, but the finished product looks and flies great.

HITS

- Easy to build.
- Complete hardware package.
- Flies well.

MISSES

- Motor wire harness difficult to install.

THE KIT

Sig Mfg.'s Kavan Ford Tri-Motor is made primarily of painted foam with some balsa and molded-plastic components. Control surfaces come hinged with installed control horns. The kit includes three Speed 280 motors, the wiring harness for connecting them to the electronic speed control (ESC) and three APC props with prop adapters. The engine pods for the wing-mounted motors come assembled, and the kit includes a full set of decals.

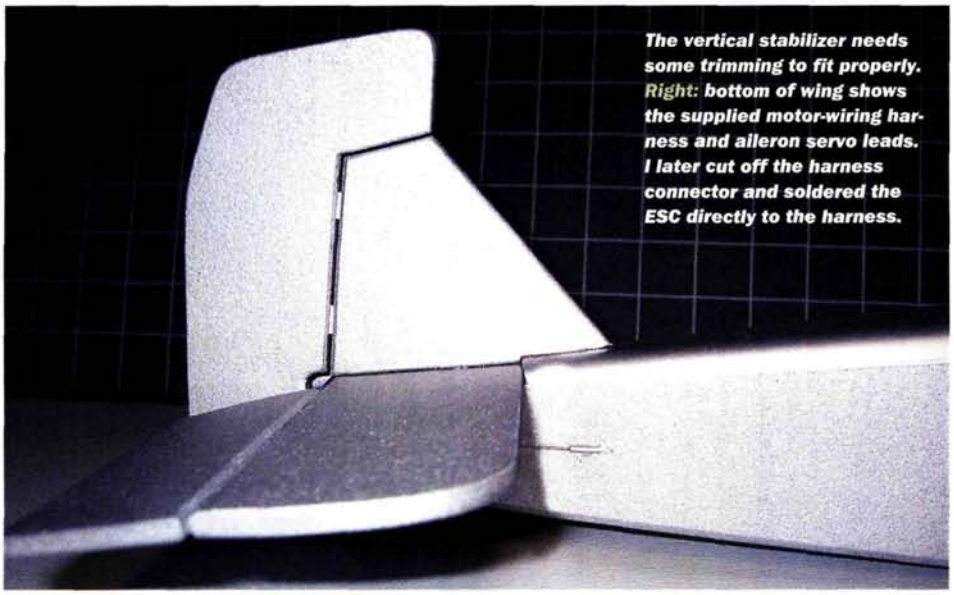
ASSEMBLY

I used Bob Smith Industries (BSI) 5-minute epoxy for most of the assembly steps, and where CA was specified, I used BSI foam-safe glue. Take care not to press on the foam very firmly, as it dents quite easily.

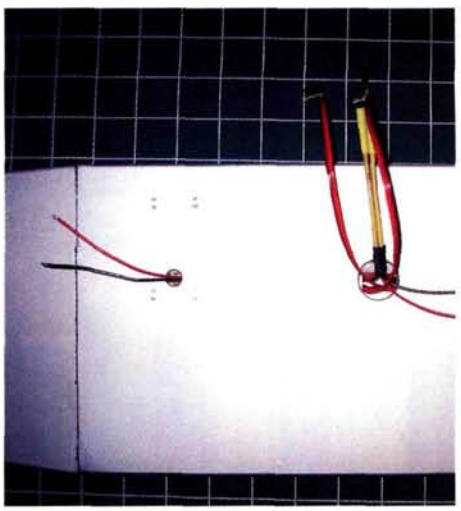
The rudder and elevator servos are attached to two balsa rails. It was easiest to first glue the rear rail into place with epoxy and then use the servos to establish the proper placement for the forward rail. Next, glue in the pushrod housing support so that the pushrods line up with the servo arms.

The horizontal stabilizer sits on a precut deck at the rear of the fuselage. After the vertical stabilizer has been glued on, add the hardwood stabilizer struts between the fuselage and the lower horizontal stabilizer surface. Insert the control rods from the rear, then attach them to the control horns and secure them with the supplied retainers. With the servo arms centered, attach the forward ends of the pushrods to the servos using the supplied hardware.

The wing consists of three foam panels, and the dihedral is established by the bevel cuts on the tip panels. Once the epoxy had cured, I attempted to route the aileron servo wires and motor wiring harness through the plastic channel in the wing. The aileron servos required extensions to reach the receiver, and it was impossible to route the motor harness along with the extension plugs, so I cut off the servo leads and soldered on longer leads to eliminate the extension plug. These fit inside the plastic channel along with the motor harness. The wing servos are held in place with double-sided foam tape. The aileron



The vertical stabilizer needs some trimming to fit properly. Right: bottom of wing shows the supplied motor-wiring harness and aileron servo leads. I later cut off the harness connector and soldered the ESC directly to the harness.



The fabulous Ford Trimotor

When you climb on board some airplanes, you get a feeling that can only be described as passing through a portal into history. As I worked my way between the rows of seats and up to the cockpit of the Ford 4AT Trimotor, I had one of those moments. There was no doubt that I was about to experience something I'd remember for the rest of my life. I was about to actually fly a Ford Trimotor.

When speaking about the Ford Trimotor, it's impossible not to reflect on some of its contradictions. On one hand, it single-handedly proved there was a market for airline travel. On the other, old Henry selected a manufacturing process—corrugated skin and massive bridge-like spar construction—that was outmoded before the first one flew. Even so, the massive old birds soldiered on, carrying smokejumpers in Montana and school kids in the Great Lakes islands well into the 1980s. Big loads and small runways are the Trimotor's "bread and butter."

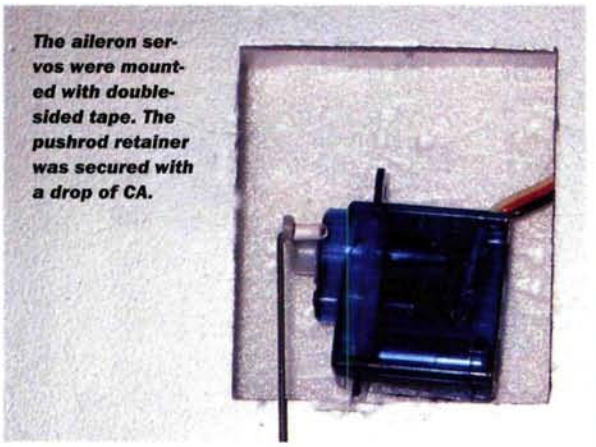
I have cranked lots of round motors, but not once—before or since—have I called starting sequences that ran "Left, middle, right." And not once have I taxied an airplane with the "Johnson Bar" braking system that consisted of a tall lever sticking out of the floor. It gave a rather Caterpillar feel to ground-handling, although when taxiing, the big rudder worked fine; and what it couldn't handle, differential power could.

Takeoff in the old penguin was a hoot! As I shoved the three levers forward, a raucous racket enveloped us, and the airplane leisurely picked up speed. I hesitated a few seconds and gave the big, oak control wheel a manly shove forward. The tail had barely come up, and I was concentrating on keeping the nose straight, when the airplane lifted off in a level attitude. I doubt whether we were doing 50mph at takeoff.

From the beginning, it became obvious that the Trimotor is a lot of things, but a dainty dancer isn't one of them. I flew the airplane for a photo mission, and as I closed on the camera plane, I found myself working hard to make the tiny movements required to slide from one position to another. Tiny movements aren't the old Ford's forte.

Landing was as much fun as the takeoff. We did only about 65mph on final and, as we closed on the runway, I brought both outside throttles to idle to fly the rest of the approach on the center engine only. In essence, I flew it like a single-engine airplane. My most notable memory of the landing was that I had to jockey the elevators back and forth as I felt for the ground; there's a slight dead spot in the elevators right at neutral, and I sort of bounced from one side of the plane to the other to plant it on the main gear in a wheel landing. The airplane squished onto those soft tires, and it took only a hint of forward pressure to nail it on. Of course, we were barely moving—at the speed of a fast walk—so keeping up with the airplane was hardly brain surgery.

I suppose a phrase that describes the Ford might be "Crude, but effective," which doesn't sound like a compliment—but it is. *—Budd Davisson*



The aileron servos were mounted with double-sided tape. The pushrod retainer was secured with a drop of CA.

The supplied jigs made easy work of aligning the motor pods.

control rods come with Z-bends at one end, and I added the 90-degree bend to attach them to the control horns. The rods are held in place by retainers made from pieces of plastic tubing. The aileron servo-tray covers are attached with clear tape.

After I had checked the wing alignment, I mixed up a batch of 5-minute epoxy and glued the wing onto the fuselage. I then fitted the engine pods to the wing using the precut jigs and glued them into place. I checked that the props rotated correctly and then soldered the motors and the wiring harness together. I epoxied the motor formers to the motor cans and then attached them to the motor pods with screws. Then I installed the fuselage motor in the same manner. A former must be glued to the fuselage motor to provide 1 to 1.5 degrees of right thrust. I screwed the fuselage nose fairing to the cowl mounts so that the prop adapter protruded approximately 2mm.

At this point, the instructions say to fit and epoxy the floats to the wing; however, if this is done now, the motor fairings could not be installed. Instead, I carefully cut out the molded Lexan motor fairings and lightly sanded them to produce a straight edge. I trial-fit the fairings to the motor pods, adjusted them slightly to get a good fit and then glued them to the motor pods. I then installed the engine cowls, the cylinder ring spacers and the tow rings according to the instructions.

The floats fit on the engine pods using the supplied jig as a guide and are then epoxied into place. I added the float struts, one at a time, while keeping the floats aligned with the jig. The exposed wood should be finished with the supplied paint. Assemble the dummy cylinders for the center motor and cut them in half using an old X-Acto blade heated with a torch. This provides a very clean cut so you can glue them around the nose fairing.

I was unable to fit the supplied battery box into place and achieve the correct CG balance point, so I laminated several foam pieces to the fuselage side and secured the battery pack to them with Velcro. This gave me a little more space to use other types of packs and to move them around to adjust the balance. I used 8, 1000mAh NiMH cells for a final flying weight of 23 ounces. I soldered the ESC to the wiring harness after I had cut off the supplied connectors. If you use the Kavan ESC, it will plug directly into the harness. I used Velcro to secure the receiver inside the fuselage.

To finish the model, I added the decals, and as I planned to land this "float plane" on terra firma, I glued 0.010-inch-thick

flight performance

For the first flight, I set the control throws as follows: ailerons 15mm (0.6 inch) up and 7mm (0.3 inch) down; elevator 20mm (0.8 inch) up and down; rudder 20mm (0.8 inch) left and right. This is slightly more than recommended, but I added some exponential to soften the controls around neutral.

TAKEOFF AND LANDING

Without a nearby lake or pond for water takeoffs, I opted to hand-launch the Tri-Motor. In a little wind and at full throttle, it took only a slight toss to get the model airborne and climbing out. At ½ throttle, the plane is very nimble but does not turn without rudder input, particularly in a breeze.

For landings, I kept the throttle just above idle until on short final, when the Tri-Motor glided down nicely. My first landing was a little hard, and the plane bounced a bit but did not suffer any harm. Subsequent landings with a shallower glide slope and a little more power facilitated uneventful slides to a stop.

LOW-SPEED PERFORMANCE

The Tri-Motor flies nicely at all power levels and shows no bad tendencies at low power settings. Power-off stalls are gentle without any tip-stall. Simply letting the plane accelerate with neutral controls allows for a simple recovery. Maneuvering at low speed is easy as long as you use coordinated rudder and aileron inputs.

HIGH-SPEED PERFORMANCE

Let's face it: this is not a high-speed airplane! At full power, the Tri-Motor climbs briskly and handles well. I did some mild aerobatics: stall turns are very easy, and the rudder is very effective. Immelmann turns are OK, but the Tri-Motor doesn't roll axially so it looks a little sloppy; rolls are best described as barrel-shaped. This is a fun plane to fly, and I hope to get it to some water to try the floats soon.

Left: holding the motor fairing with the proper alignment allows you to mark the correct site for cutting the hole to accommodate the undercarriage strut. Below right: here you see the laminated pieces of foam used to center the battery pack laterally. The receiver, ESC and battery pack were mounted with Velcro. Receiver foam is wedged between the battery pack and the opposite fuselage side to hold the pack in place.

pieces of clear Mylar to the bottom of the floats for protection.

FINAL THOUGHTS

This is a fun airplane! It took a little longer to build than I thought it would because of the Lexan motor fairings, but the finished product is very stylish, and it flies great. Although I didn't fly from water for the flight testing, I'm confident that Sig's Kavan Ford Tri-Motor with its scale floats will perform equally as well from a "wet" runway.

APC Props; distributed by Landing Products (530) 661-0399; apcprop.com.

Bob Smith Industries (805) 466-1717; bsiadhesives.com.

Hitec RCD Inc. (858) 748-6948; hitecrcd.com.

JR; distributed by Horizon Hobby Inc. (800) 338-4639; horizonhobby.com.

Kavan; distributed by Sig Mfg.

Sig Mfg. Co. Inc. (800) 247-5008; (641) 623-5154; sigmfg.com.

HOBBY LOBBY

Simprop Lift Off XS

BY DAVE GARWOOD

PHOTOS BY DAVE GARWOOD

You'll like this high-performance hotliner

Simprop Electronics is known for its innovative, high-quality kits, and this electric hotliner is one to get excited about. Advance the throttle and launch the Lift Off XS with a gentle toss. It leaps out of your hand. Pull the elevator stick back to start an unlimited 80-degree climb. After 15 seconds, the Lift Off XS reaches "too small to see" height. This magnificent climb performance is a precursor to the model's solid response to control inputs and its impressive ability to move very rapidly around the sky.

SOPHISTICATED DESIGN

This kit is crammed with intelligent design ideas and high-quality parts. Start with the simple method for installing the horizontal stabilizer accurately. Both the stab and the wing are removable, so the Lift Off XS fits into its original box for compact storage and easy transportation.

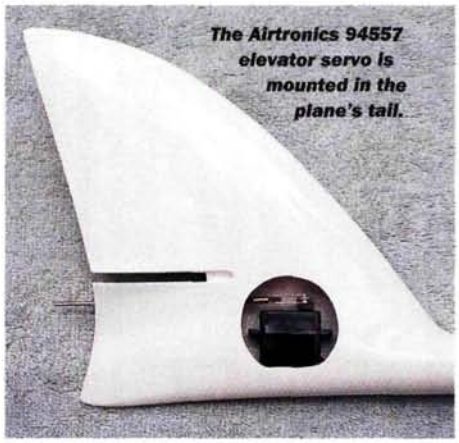
In the Lift Off XS, the receiver is mounted behind the battery pack. Increasing the distance between the receiver and the motor minimizes the risk of radio interference that can cause a loss of control and even a crash.

Finally, the Lift Off XS delivers exceptional high-performance flight characteristics. Simprop has gotten the combination of the airfoil, wing planform, moments, recommended power system, overall weight and control throws just right. Whether it climbs energetically, dives furiously, or rolls 720 degrees per second, the plane feels smooth, solid and controllable. It is a highly satisfying model to fly.

KIT CONTENTS

The Simprop Lift Off XS kit features fully sheeted, covered wings and horizontal stabilizer and a beautifully molded fuselage with a molded-in vertical stabilizer. The small parts include die-cut light poplar plywood parts for the battery holder, a large sheet of decorative stickers, all necessary hardware and two types of adhesive: wood glue and a special servo-mounting compound.

The kit includes a large sheet of drawings with German text and an 8-page construction/instruction manual translated into English. The wing halves are made by a proprietary heat-and-pressure method.



The Airtronics 94557 elevator servo is mounted in the plane's tail.

Also included is a padded bag to protect the wing halves.

Although the kit requires very little assembly, you'll need these tools to complete the project: a drill to mount the motor and the control horns; a grinder or small file set to shape the cooling holes; and screwdrivers (flat-blade and Phillips) to mount the servo tray and the servo arms. You may also use a covering iron to touch up the edges of the Oracover heat-shrink wing and tail covering.

POWER AND RADIO GEAR

For power, I installed an AXI 2820/10 brushless external rotor system, a Jeti Model Advance 40-3P brushless speed control, an Aeronaut CAM-Carbon 12.5x9-inch folding prop and a Hobby Lobby B1700C8 8-cell, 1700mAh Ni-Cd battery pack. All of this equipment is available from Hobby Lobby.

I also installed an Airtronics 92777 receiver, three Airtronics 94557 Microlite high-torque servos, a pair of Airtronics 6-inch extension cables for the aileron

specifications

MODEL: Lift Off XS

MANUFACTURER: Simprop Electronics

DISTRIBUTOR: Hobby Lobby Intl.

TYPE: high-performance electric hotliner

WINGSPAN: 62 in.

WING AREA: 341 sq. in.

WEIGHT, AS TESTED: 2 lb. 15 oz.

WING LOADING: 19.97 oz./sq. ft.

LENGTH: 36 in.

MOTOR USED: AXI 2820/10 brushless

PROP USED: Aeronaut CAM-Carbon 12.5x9

BATTERY USED: 8-cell, 1700mAh Ni-Cd

RADIO REQ'D: 3-channel with 3 microservos (ailerons [2] and elevator) and Jeti 40-3P ESC

RADIO USED: Airtronics VG-6000 transmitter, 92777 receiver and 3 Airtronics 94557 Microlite high-torque servos

PRICE: $249

FEATURES: fully prebuilt airframe with molded and finished fiberglass fuselage. Elevator servo in the tail eliminates long pushrod. Built and covered veneer-sheeted, foam-core wings and horizontal stabilizer; hinged ailerons; complete small hardware set; molded canopy; decals; construction drawings. The two-section wing and removable horizontal stabilizer allow the model to fit back into its original box for storage and transportation. A padded bag is provided to protect the wings.

COMMENTS: a truly excellent electric model for those who like to climb fast and tear up the sky.

HITS

- Beautifully molded and finished fiberglass fuselage.
- High performance and rapid climb rate.
- Horizontal tail mount is part of fuselage molding.
- Hardware includes all the small parts you need.

MISSES

- English translation of German instructions is adequate but could benefit from additional editing.

power to spare

I installed the wonderful AXI 2820/10 brushless, rotating-can system for this review. This unit delivers plenty of torque without a gearbox. I also fitted a Jeti Model Advance 40-3P brushless speed control, an Aeronaut CAM-Carbon 12.5x9 folding propeller and a Hobby Lobby B1700C8 8-cell, 1700mAh Ni-Cd battery pack.

The initial prop speed in my testing was 6,840rpm, with the motor drawing 37.1 amps. The ESC cut the power at 7 volts, pulling a total of .901mAh from the battery pack. Cooling was sufficient, as at the end of the run the motor temperature was 80.4 degrees F, and the battery pack temperature was 115.3 degrees F when the ambient temperature was 56.8 degrees F. My ESC appears to be calibrated to cut the power to the motor (but continue to power the receiver and servos) at a higher value than other ESCs I've tested over the years, but the motor/battery/prop combination is so powerful that the 1.75-minute, full power-on time easily delivers flights of 8 minutes or more because of the long cruising and gliding times between short motor run times.

Lift Off XS with motor, props and spinners; all of these parts are from Hobby Lobby. If you want the Lift Off to look its best, use the white plastic spinner but the turbo-cool aluminum spinner offers maximum cooling.

flight pack electrical performance

MOTOR: Model Motors AXI-2820/10 brushless, rotating can
PROPELLER: Aeronaut CAM-Carbon 12.5x9 folding
SPEED CONTROL: JETI Model Advance 40-3P (brushless)
BATTERY PACK: Hobby Lobby B1700C8 700mAh Ni-Cd

	RPM	AMPS	VOLTS	WATTS
Start, with freshly peaked battery	6,840	37.1	8.1	282
After 1 minute at full throttle	6,120	32.1	7.9	236

ESC CUTS MOTOR POWER AT: 1 min., 42 sec. (7 volts, .901Ah)
MOTOR TEMP AT END OF RUN: 80.4 degrees F
BATTERY PACK TEMP AT END OF RUN: 115.3 degrees F
AMBIENT TEMPERATURE: 56.8 degrees F

NOTES

1. Battery pack cycled five or more times on the bench.
2. Battery packs peaked on AstroFlight 110-DX charger just before testing.
3. All removable connections fitted with Deans Ultra Plug connectors.
4. Electrical measurements made with AstroFlight 110 watt meter.
5. Propeller speed measurements made with a Hobbico GloBee IntelliTach.
6. Temperature measurements made with DuraTrax infrared temperature gauge.
7. Flight duration can be greatly increased by throttling back during flight.

servos and a 12-inch extension cable for the elevator servo.

The 94557 Microlite servos fit nearly flush into the wing, so the provided servo covers were unnecessary. By enlarging the aileron servo bays slightly, I came within about 1/32 inch of a flush mount.

CONSTRUCTION

The Lift Off's construction goes quickly because its flying surfaces are finished and covered. Start by marking and cutting holes in the nose for motor-mounting and cooling air inlets, and cut the cooling outlet holes marked just in front of the canopy opening. Sand the molded canopy slightly to fit closely, and install the canopy hold-down wire with Goop glue. Build the battery tray, and mount its hold-down part to the fuselage with Goop or epoxy. After you've installed the horizontal stabilizer, the wing-incidence pin and three control horns, the airplane is essentially built. Construction took me about 8 hours.

Install a pair of microservos in the wing and one in the tail with either the sticky servo-mounting material provided or Goop. When you install the motor and ESC, pay close attention to the wire lengths so they lie flat and can be taped out of the way of the rotating-can motor. Install the servo-control linkages, set up the control throws in the transmitter, apply the markings, check the balance, and you're finished. Charge the transmitter and your flight packs, and you're ready to fly.

I made three modifications to the recommended instructions: I installed a beefier motor mount and a modified battery tray, and I added a base-loaded receiver antenna so I wouldn't have a long receiver wire dangling outside the airplane.

The instructions for the rotating-can motor caution the builder to make sure that the motor is solidly mounted to avoid vibration. I installed a circular 1/8-inch-thick plywood plate behind the nose mount. I don't know whether it was necessary, but the price of plywood from the scrap box and a trip to the hardware store for longer motor-mount bolts was worth the peace of mind.

Also, I replaced the lite-ply battery mount in the kit with a slightly longer 1/16-inch-thick birch ply tray that holds the battery, the receiver and the short receiver antenna. This idea is from another Simprop design—the SE-300. The battery is mounted with Velcro, and the receiver and antenna are mounted with double-stick servo-mounting foam. The hex-head screws that secure the extended tray in the fuselage are screwed into spruce rails glued into the fuselage with Goop.

flight performance

LAUNCHING AND LANDING

You can hand-launch the Lift Off XS without running. Just apply full power, and toss it with the wings level and the nose pointed at the horizon. In a few seconds, it will reach full speed; pull back the elevator stick gently, and the plane will climb quickly and positively. The external-can motor and large-diameter propeller provide impressive acceleration and climb power (as if the motor were geared) but without the gear noise and extra parts.

The Lift Off XS cruises rapidly for long distances, even with the power off, so line up for landing with plenty of clear area available to avoid obstacles. Cut the power, keep the wings level and let the model descend in a flat glide until it meets the ground.

LOW-SPEED FLIGHT

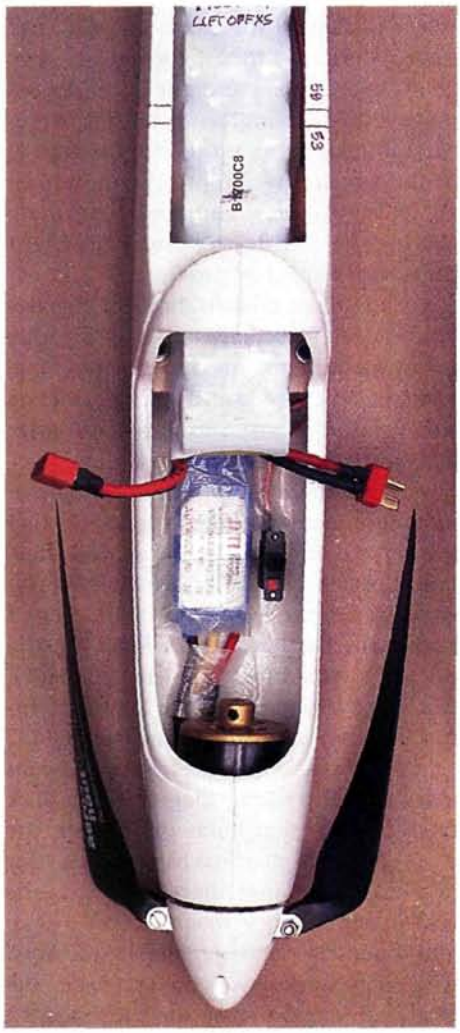
For cruising and landing, the Lift Off XS will slow down to a medium speed, but it isn't a slow flyer. After it reaches cruising altitude, you can cut the power to 30 percent, and the Lift Off XS will maintain its altitude. When forced into an intentional forward stall, it falls off to one side or the other, but after a brief dive and application of opposite aileron command, it quickly regains flying speed and positive control. With the thin wing section and substantial wing loading, the Lift Off XS is much happier when it is kept moving.

HIGH-SPEED FLIGHT

This plane is designed and powered to rapidly climb, dive and cruise, and it quickly covers large expanses of sky in all three dimensions. With the prop folded, it can pour on impressive speed in a dive, and it uses its kinetic energy after pulling out of a dive to zoom back up to altitude. It is exceptionally well-balanced in aileron and elevator control. It isn't difficult to fly; it just wants to fly fast, which is exhilarating for many pilots. Those who are comfortable with fast flying will be rewarded with remarkably enjoyable flights with the Lift Off XS.

AEROBATICS

The Lift Off XS handles so well that it encourages high-speed, graceful, sky-filling aerobatics. The plane tracks accurately through inside loops and will pull outside loops. With light elevator stick pressure to hold the nose up, inverted flight is easy. Rolls are quick and axial. As it doesn't have a rudder, it can't do rudder maneuvers, but ailerons and elevator combine to deliver fine Cuban-8s and split-Ss. The combination of high climb rate and high energy retention allowed me to launch, climb with power on for 15 seconds, roll into a split-S and glide through 15 loops on the way down before I had to apply power again.

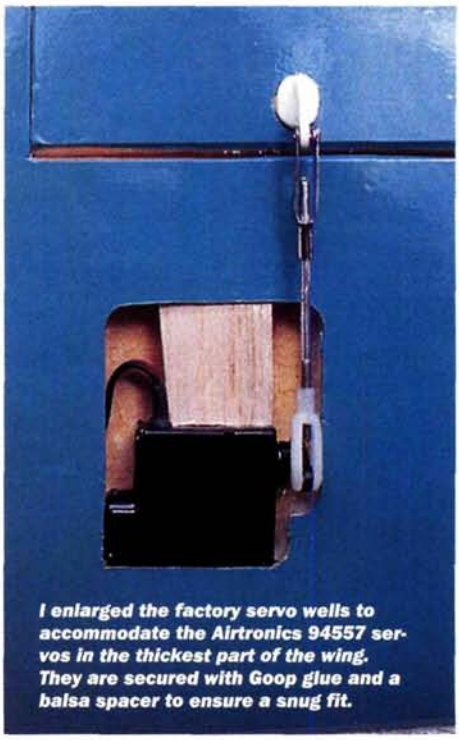


Onboard equipment with battery tray and receiver mounting installed.

With the receiver in the specified position behind the battery pack (an excellent location—as far from the motor as possible), the receiver antenna will trail the plane by 24 inches—⅔ the length of the fuselage. This is not only unsightly but can also be a safety hazard, as the dangling antenna may become entangled on launch. My solution was to mount a W.S. Deans Model 1101 base-loaded antenna inside the rear fuselage. Bobby Tom, chief of the radio service department at Airtronics, gave me instructions for an enhanced ground range check: "With the transmitter antenna collapsed, stand 100 feet away from the plane, and with the motor on and off, move the controls while the plane is facing you and while it's pointed away from you. The controls should be rock solid. If they are, then it's OK to fly the plane with that modified antenna." I performed this range check; the Deans antenna passed, and I've been flying my Lift Off XS with the small, base-loaded antenna.

BUILDER'S THOUGHTS

The Lift Off XS is a joy to fly; Simprop Electronics did everything right. It launches with an easy toss—no need to run. It climbs so rapidly that I tend to cut the power after about 12 to 15 seconds and then cruise or wring it out to push my personal aerobatic repertoire. Throughout its flight envelope, the Lift Off XS provides a swift, powerful, predictable and exhilarating flying experience. ✈



I enlarged the factory servo wells to accommodate the Airtronics 94557 servos in the thickest part of the wing. They are secured with Goop glue and a balsa spacer to ensure a snug fit.

Airtronics *(714) 978-1895; airtronics.net.*
AstroFlight Inc. *(310) 821-6242; astroflight.com.*
DuraTrax; *distributed by Great Planes; duratrax.com.*
Great Planes Model Distributors *(217) 398-6300; (800) 682-8948; greatplanes.com.*
Hobbico; *distributed by Great Planes; hobbico.com.*
Hobby Lobby Intl. *(615) 373-1444; hobby-lobby.com.*
Simprop Electronics; *distributed by Hobby Lobby.*
W.S. Deans Co. *(714) 828-6494; wsdeans.com.*

Giant-scale aerobatic fun!

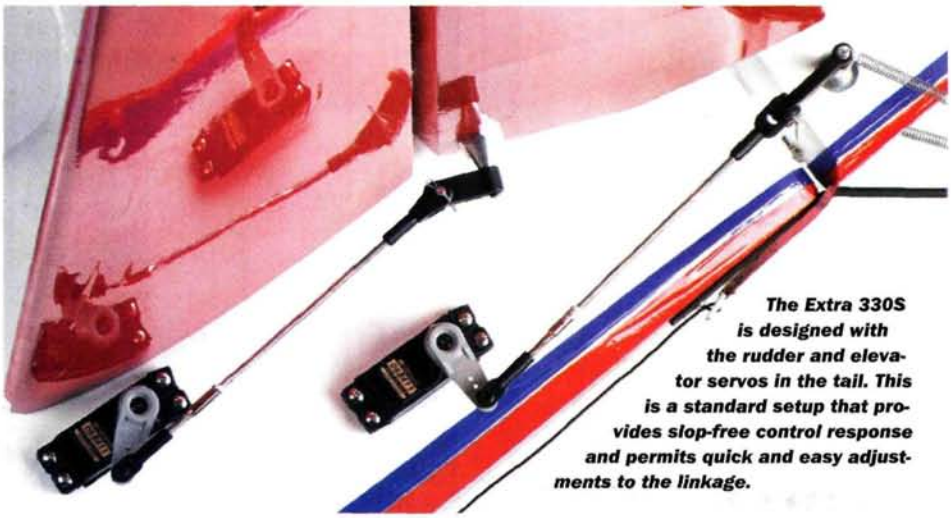
The Extra 330S is Hangar 9's newest plane in the 33% category. Designed by veteran Tournament of Champions pilot Mike McConville, it incorporates design features and enhancements that have been gleaned from his many years in competition. The Extra 330S will satisfy the needs of serious competitors, but it is also an excellent, stable-flying aircraft. It can be fine-tuned to perform precision aerobatics and tweaked to fly wild, 3D-style aerobatics as well.

HANGAR 9

Extra 330S

BY JOHN REID

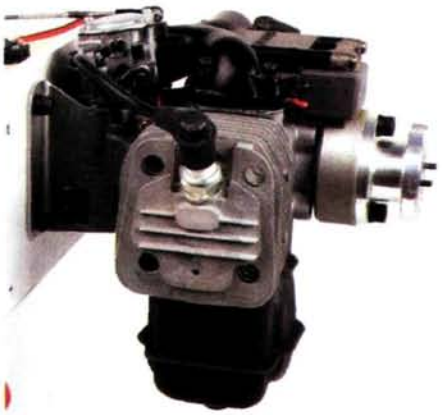
PHOTOS BY JOHN REID



The Extra 330S is designed with the rudder and elevator servos in the tail. This is a standard setup that provides slop-free control response and permits quick and easy adjustments to the linkage.

WHAT'S IN THE BOX?

The Hangar 9 Extra 330S arrives in two boxes. The larger box contains the balsa-and-ply fuselage, built-up balsa rudder, fiberglass painted cowl and wheel pants, canopy, wing tube, aluminum landing gear, decal set and a 48-page manual. The second box contains the right and left wing panels with ailerons; these parts are individually wrapped for protection. The left and right stabilizers with the elevators are also wrapped and taped down for protection during shipping. You'll need to provide an engine, radio gear, your favorite hardware and, of course, a really cool pilot figure. Hangar 9 offers a complete, 1/3-scale hardware package (sold separately for $149.95) that's made especially for the Extra 330S.



The Zenoah GT-80 twin-cylinder engine is ideal for powering the Extra 330S. The throttle servo is just aft of the firewall for simple throttle-linkage setup.

CONSTRUCTION

As with nearly all almost-ready-to-fly (ARF) planes, I began my construction by removing the wrinkles in the covering. The Hangar 9 UltraCote did not require much shrinking, but because this is such a large airplane, you should allow yourself enough time to work over all the surfaces with a covering iron. I also gathered up all the hardware necessary for completing the plane. At the time I was building this plane, Hangar 9's 1/3-scale hardware package wasn't yet available, so I used high-quality Du-Bro products, all of which fit perfectly.

WING CONSTRUCTION

The manual begins with instructions for assembling the wings. You only have to hinge the ailerons and install the servos. Because this is a big plane, it requires two servos for each aileron. I selected the JR DS 8411 digital servo for all of the control surfaces because of its quick response and powerful torque. I also used a JR MatchBox on each of the ailerons, the elevator and the rudder to make it easier to synchronize the servos for each surface. Each servo required a servo extension that I attached firmly with shrink tubing; this will prevent anything from coming loose inside the wing. After I had screwed the servos in tightly, I used the methods outlined in the instructions to attach the control horns to the ailerons. Du-Bro's heavy-duty control horns were great for this application; they make solid, reliable connections.

Detailed instructions explain how to install and hinge the ailerons; the same method is used for the elevators and rudder. The control surfaces are drilled out for Robart hinge points. I like to use Vaseline on the knuckles of the Robart hinges to prevent epoxy from seeping in during assembly. I also roughen up the hinge points with 100-grit sandpaper. It is important that the hinge pivot pins be parallel and flush with the aileron's leading edge. Install the hinge points in the ailerons first, and allow them to dry. After the epoxy has fully cured, I work each hinge point back and forth until the hinge can move throughout its full travel without resistance. Attach the ailerons to the wings using this same method. Press the ailerons onto the wing so that there is a 1/64-inch gap between the aileron and wing's hinge line. After the epoxy has cured, deflect the surface fully until there is full travel with little or no resistance.

specifications

MODEL: Extra 330S

MANUFACTURER: Hangar 9

TYPE: 1/3-scale aerobatic

WINGSPAN: 97 in.

WING AREA: 1,750 sq. in.

WEIGHT: 25.4 lb.

WING LOADING: 33.74 oz./sq. ft.

LENGTH: 83 in.

ENGINE REQ'D: 3.8 to 4.8ci 2-stroke gas

ENGINE USED: Zenoah GT-80

RADIO REQ'D: 4-channel w/9 servos

RADIO USED: JR 10X w/8 DS 8411, 1 537 and 4 JR MatchBox servos

PROP USED: 24x10 Pro Zinger; Tru-Turn spinner

PRICE: $849.99

FEATURES: fuselage is all lite-ply and balsa construction with built-up balsa-constructed wings, elevator and rudder; painted fiberglass cowl and wheel pants, heavy-duty aluminum main gear, clear-plastic canopy hatch, metal wing tube, decal sheet and a 48-page instruction manual (including a section on flying various maneuvers) are all included.

COMMENTS: for a large aircraft, the Extra 330S goes together quickly. This plane is designed to be light and extremely responsive, and it fulfills both of those ambitions quite well. The Zenoah GT-80 is a perfect engine for this plane; it allows unlimited vertical performance and has more than enough power to pull the plane through any maneuver with authority.

HITS

- Excellent construction.
- Well-thought-out design and assembly.
- Manual includes setup and flying tips.

MISSES

- Hatch assembly can warp if you're not careful.

To prevent the fuel pick-up clunk from shifting forward in the tank, I installed a short length of brass tube in the internal fuel line.

The large hinge gaps on the control surfaces of the Extra 330S need to be sealed to prevent any flutter. Hangar 9 suggests that you use a strip of 3-inch-wide clear UltraCote that has been folded in half and ironed onto both sides of the hinge line (wing and aileron). This method is easy and works quite well. Sealing the aileron, elevator and rudder hinge lines is extremely important. If you fail to do this, the resulting surface flutter may very well cause a crash.

I centered the servos by connecting them to the receiver and turning on the transmitter. I then hooked up the aileron control rods to the control horns and servo arms. The wings were now finished and could be set aside; I attached them later when I was ready to adjust all the control surfaces.

RUDDER AND ELEVATOR

Install the rudder and elevator servos in the rear of the fuselage. Each of these servos also requires a servo extension and is held together with heat-shrink tubing. There is a servo for the elevator on each side and two servos (one on each side) for the large rudder. Install these control surfaces using the same method (Robart hinges and UltraCote for the hinge gap) as was used for the ailerons. After you've hinged the stabilizer and elevator, attach them using two stabilizer tubes. Insert two metal tubes through the aft end of the fuselage (just below the rudder fin), and then slide the stabilizers onto these tubes and secure them with 4-40 bolts screwed into each tube. This method of attachment allows easy stabilizer removal when you transport the plane to and from the field.

Attach an elevator servo to the elevator control surface on each side of the plane. I used the new, heavy-duty control-horn system from Du-Bro for the rudder; this is essentially a pull-pull system that uses solid pushrods instead of wires. I used a JR MatchBox for the two elevators and another one for the two rudder servos. It made it simple to adjust the servos to synchronize with each other, so there won't be any excess resistance caused by the servos working against each other. With the installation of the tail feathers complete, I moved on to the fuselage.

FUSELAGE CONSTRUCTION

Install the landing gear in the belly of the fuselage. It is attached to a solidly constructed undercarriage with four 10-32x1 hex-head bolts. I made the appropriate cutouts on the wheel pants and installed them, too, along with the wheels before moving on to the tailwheel. I used screws and two springs to attach the tail bracket to the rudder control horns to move. This allows the tailwheel to move in sync with the rudder movement.

I found an appropriate spot on the side of the fuselage for the receiver switch and

With such big control surfaces, it's important to seal the hinge gap with a strip of covering material. Be sure to securely iron the hinge gap seal into place.

installed the receiver and battery pack inside the fuselage. I made ⅛-inch plywood receiver and battery trays and epoxied them in the fuselage at the recommended locations. I wrapped the battery, receiver and two JR MatchBoxes in foam and secured them with rubber bands. I also wrapped the fuel tank with foam, placed it on the floor of the tank compartment and secured it with rubber bands. I attached the rubber bands to small cup hooks screwed into the tank floor.

Attach the canopy to the hatch assembly; use four, 4-40 hex-head capscrews to secure it to the fuselage. I installed my custom-made ⅓-scale pilot figure using screws and Zap-a-Dap-a-Goo II. After that had dried completely, I sealed the canopy to the hatch assembly using RCZ56 canopy glue. Be sure to install the canopy while the hatch assembly is attached to the fuselage. I installed the canopy while the hatch was off the plane, and after everything had dried, I discovered that the hatch had warped somewhat.

ENGINE AND COWL INSTALLATION

Hangar 9's manual supplies step-by-step instructions to install the Zenoah GT-80 engine, and it was extremely easy to do. I bolted the engine to the firewall with the provided four ¼-20x½ hex-head screws. I made a cutout for the throttle servo on top

My intrepid pilot, complete with his* Model Airplane News *baseball cap. I got this handsome guy from Vailly Aviation.

of the engine box and then screwed it into place. I connected the linkage to the carburetor from the servo arm. For safety, I installed an electronic kill switch for the engine. This switch (which is available from RCATS) allows me to designate an unused transmitter channel as a kill switch.

To complete the engine installation, I used a rotary tool to make the necessary cutouts in the cowl to accommodate the engine. Following the instructions, I also cut a large air outlet into the aft end of the cowl. I mounted the cowl using five 4-40x¾ hex-head screws. I balanced a 24x10 Pro Zinger prop and mounted it with a Tru-Turn spinner to complete the cowl installation.

FINAL ASSEMBLY

Balancing a plane of this size requires two people—one at each end of the wing. Using our index fingers, my helper and I lifted the plane at the balance point. Because of the detailed instructions, we only had to adjust the position of the battery pack to balance the plane.

Although a computer radio is not required for this plane, having one really makes the radio setup much simpler. This is especially true if you want to use any type of computer mixing such as flaperons,

flight performance

The Zenoah GT-80 provides plenty of power for all but the most aggressive vertical maneuvers. The plane can pull itself out of a hover, but it requires a bit of patience. I'm sure if I had taken the time to properly tune the engine for my altitude and experimented with different props, I would have found its vertical performance to be even better. As it stands, I am very pleased with the power-to-weight ratio of this combination.

TAKEOFF AND LANDING

Whenever I test-fly a high-performance model such as this, I triple-check every nut, bolt, control throw, hinge and the center of gravity, but I found that as usual, John Reid had done a superb job of putting this beast together. After a few taxi trips down the runway and back, I checked the wind and the pattern and rolled on the throttle. The big Extra tracked very true and stayed right on the centerline with just a little pressure on right rudder. As soon as the wheels left the ground, I knew that I would have a hard time giving the radio back to its rightful owner!

Landing this plane is simple because it's a bit of a floater. My first approach was slightly high, so I decided to abort. I'm always careful to ease into the throttle with these big gassers, particularly when I'm low and slow. The second approach was much better, and I managed a pretty good 3-point landing. Subsequent landings proved to be equally easy. The key is to fly a shallow approach with a few clicks of throttle. When the Extra reaches the runway's threshold, I chop the throttle to idle and carefully add up-elevator until the wheels touch down.

LOW-SPEED PERFORMANCE

In my mind, there are two modes of low-speed flight for a plane like this: 3D and normal. In normal flight attitudes, this Extra gives noticeable warning before it enters a hard stall. The flight controls start to become "mushy," and you certainly can tell that it wants some power so it can fly normally again. If the envelope is pushed and a stall is forced, the Extra will drop its nose and "porpoise" until power is added or altitude is traded for airspeed.

In 3D/High Alpha flight, the Extra maintains positive control throughout the entire flight envelope with proper use of high-rate throws and throttle management. The JR 8411 digital servos provide excellent response, and the limiting factor is definitely my own reaction time—not the servos'. Elevators are very stable, and harriers don't even require full throw on high rates. High Alpha knife-edge, rolling harriers, waterfalls—quite simply, every 3D maneuver that I know how to do—are all easily within the capabilities of this plane. With the GT-80 and the Zinger prop, I was able to easily hover at a tick below ½ throttle. Torque rolls are slow and graceful, and once the sweet spot was found (for me, this was almost perfectly vertical with a hint of right rudder and a touch of up-elevator), only small corrections were required to keep going around and around. I have never professed to be a master of aerobatic or 3D flight, but this plane makes me look good!

HIGH-SPEED PERFORMANCE

Although low-speed performance can be coupled with 3D aerobatics, I like to separate high-speed performance from traditional aerobatics simply because there is a whole class of large planes that is dedicated to speed but is not intended to perform aerobatics competitively.

The Zenoah GT-80 will definitely haul this plane around at a very high rate of speed, but I wouldn't recommend flying it at full throttle unless it is in a vertical upline. As with any large plane, throttle management is critical. Never fly downlines with anything more than one or two clicks of throttle, if that. The Extra is an easy-to-fly aerobat, but you must pay constant attention to the throttle.

AEROBATICS

Aerobatic performance is where the Extra lives and what it was designed to do. It is an extremely neutral-flying plane; each individual control surface has very little impact on the others. For example, in straight knife-edge flight, absolutely no roll correction is required, and I noted only a touch of coupling toward the belly. Flat turns are done almost purely with rudder, with just a hint of elevator correction needed. Point rolls are exceptional; rolls are axial. With the proper application of a little elevator and rudder at the appropriate times, even slow rolls are a cinch. One of my favorite maneuvers is a very slow flat spin, which I was able to do on low rates at idle. It is quite graceful and easy to fly away from by adding throttle while neutralizing the rudder and aileron and easing off the elevator until airspeed is gained. Snap rolls are very clean and precise, but they require a bit more finesse with the Extra than with most smaller aerobatic planes. In the flight tips section at the end of the construction manual, Mike McConville gives the best advice for snaps: start a snap roll normally, but as soon as the sticks reach the corners, neutralize the elevator to prevent losing too much airspeed and getting too "deep" into the maneuver.

For pilots who want to compete in IMAC on a serious level or for weekend warriors who want to polish their repertoire, the 33% Hangar 9 Extra 330S is the plane that can get it done with style.
—Jet Thompson

rudder-to-aileron and rudder-to-elevator which, of course, I did! I set the controls to the recommended throws for both standard and 3D maneuvers. I also included exponential settings that matched the prototype model setup outlined in the instructions.

CONCLUSION

The Hangar 9 Extra 330S is a great-looking plane, and because of its size, it will attract a lot of attention at any flying field. Its great flight characteristics and handling performance make this an outstanding plane to own and fly. If you've wanted to get into 3D aerobatics or precision flying in a big way, you can't beat the Hangar 9 Extra 330S. ✈

Du-Bro Products *(800) 848-9411; dubro.com.*
Hangar 9; *distributed by Horizon Hobby Inc.*
Horizon Hobby Inc. *(800) 338-4639; horizonhobby.com.*
RCATS *(408) 292-9794; rcatsystems.com.*
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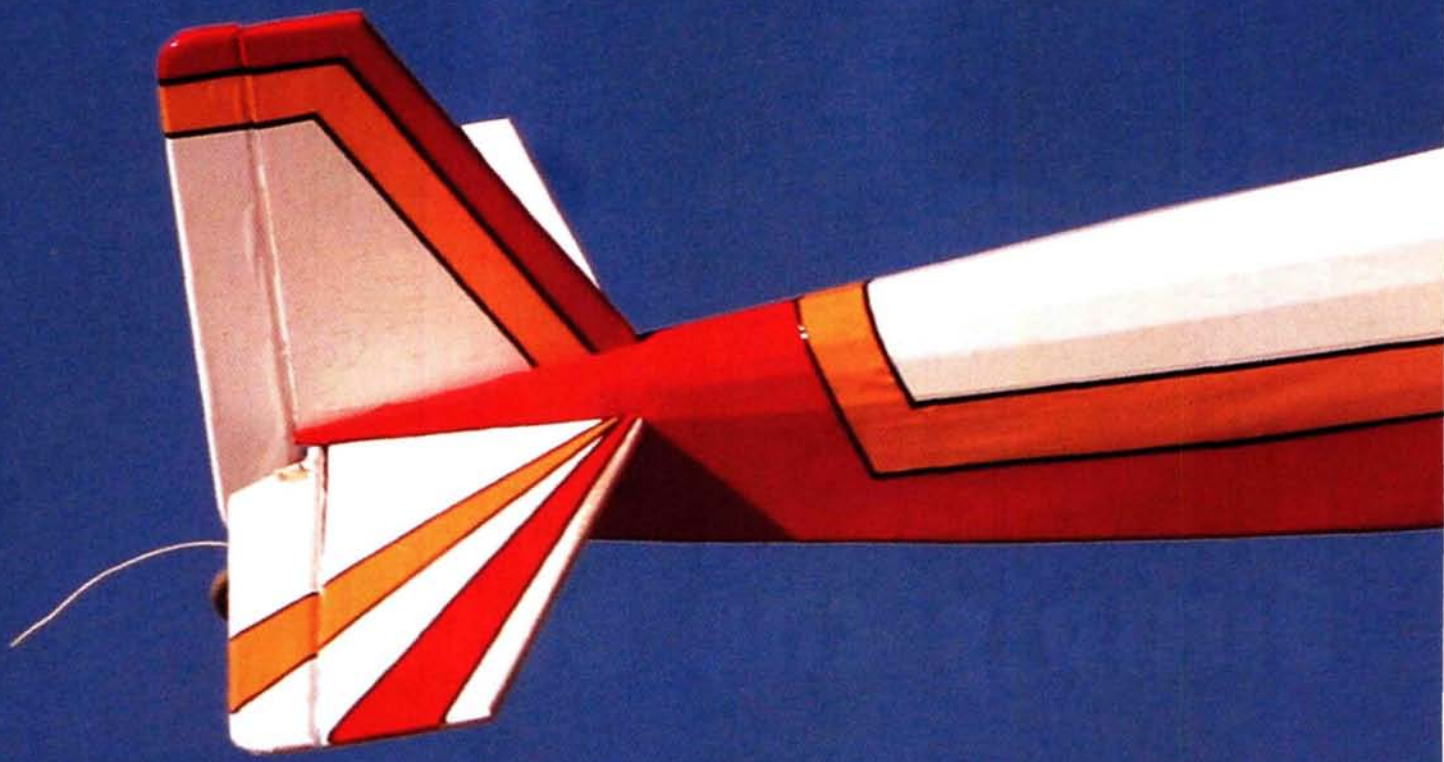


GREAT PLANES

Rapture 40

BY ROBERT REID

PHOTOS BY JOHN REID

A sport-flyer kit that's a joy to build!

No offense to ARFs, but I enjoy building my own planes. I like the process of fitting wooden parts together to create an airframe out of sticks and blocks. I also like being able to cover a plane in the way I want—not just accepting the scheme that comes from the factory. Most of all, I like flying my finished models and knowing that my hands built the aircraft that looks so good over head. So when *Model Airplane News* offered to let me review the Great Planes Rapture 40 kit, I couldn't wait to get started.

The laser-cut, lite-ply fuselage snaps together easily, creating a very light, strong framework.

specifications

MODEL: Rapture 40

MANUFACTURER: Great Planes Model Mfg.

WINGSPAN: 60 in.

WING AREA: 635 sq. in.

WEIGHT: 4.5 to 5.25 lb. (5 lb. as built)

WING LOADING: 16 to 19 oz./sq. ft.

LENGTH: 46.5 in.

RADIO REQ'D: 4-channel w/4 servos

RADIO USED: Airtronics VG 600 w/94102 servos

ENGINE REQ'D: .40 to .50 2-stroke or .40 to .52 4-stroke

ENGINE USED: Magnum XL46

PROP USED: Top Flite 10x6

FUEL USED: Powermaster PowerBlend 15%

PRICE: $94.99

FEATURES: die-cut balsa and ply parts; landing gear; hardware; vacuum-formed clear-plastic canopy; adjustable engine mount; full-size rolled plans; photo-illustrated instruction manual.

COMMENTS: the Rapture 40 has high-quality parts and is an enjoyable build. At the field, it is stable, yet it can easily handle basic aerobatics. Great Planes has another winner!

HITS

Accurate die-cut parts.

Complete hardware package.

Straightforward, fast-building project.

MISSES

None.

OUT OF THE BOX

I have built a few Great Planes kits, and their high quality has always impressed me. The Rapture kit was no exception. The balsa was covered with clear plastic, and the hardware was in plastic bags. Pushrods for the elevator and rudder, landing gear, a vacuum-formed, clear-plastic canopy and an adjustable engine mount are included, as are full-size rolled plans and a 43-page manual with numerous pictures showing every stage of the construction. A 2-page drawing of the plans is in the center of the manual; this is a handy reference source when you have to double-check something. On the back of the manual, a 2-view drawing of the plane helps you to plan your trim scheme (the box even shows two schemes).

The wing joints fit together nicely. Only the center of the wing requires sheeting for additional strength.

CONSTRUCTION

Construction begins with the fin and rudder. There is a pattern for the fin base on the plans, and instead of cutting up the plans, I made photocopies of the patterns. Building the fin is very straightforward and poses no problems.

You proceed with the elevator in the same way, cutting out the pattern for the stabilizer leading-edge brace. Then it's just a matter of cutting the ¼x¼-inch balsa to size. No surprises here! Next, cut out the elevators. Now is a good time to hinge the rudder and the elevator; CA hinges are included in the kit along with very detailed instructions on how to install them.

The wings are built over the plans, so make sure you cover the plans with wax paper. The die-cut parts for the wings are very clean and crisp and require little, if any, sanding. Great Planes emphasizes building simplicity. It uses ⅜x⅜-inch-square balsa for the top and bottom spars, and this eliminates the need for wing sheeting, except in the center of the wing. This greatly speeds up the building process. The leading edges are already formed, and the wingtips are die-cut and ready to glue. It took me only a couple of evenings to frame up both wing panels. When they have been framed up, you can add the center wing sheeting and the shaped trailing edges (cut a groove for the aileron torque rods). Now it's time to add the CA hinges to the wings. Make sure the ailerons have ½ inch up-and-down movement according to the instructions. You have to glue three pieces of ⅛-inch plywood together to make the wing joiner; dry-fit the wing halves to make sure that you have the proper contact and dihedral. There is a die-cut plywood aileron servo tray; glue this to the wing and center it over the servo opening. Set the wing aside and start the fuselage.

The fuselage sides are ⅛-inch plywood. Glue the wing-saddle doublers to the fuselage sides, being sure to make a right side and left side. The fuselage just snaps together—almost like putting a puzzle together. It's very easy and quick. The 2-degree offset for the engine is already built in. After the fuselage has been framed up, mount the wing and install the guide tubes, the tank tray and the included engine mount. There are hardwood servo-mount rails. After you've made sure that everything fits, sand everything smooth. I generally start with 80-grit and then switch to 120-grit and finish with 220-grit.

FINAL STEPS

I used my air compressor to blow away all the sawdust, and then I wiped the plane down with a tack cloth. I used white Coverite for my base color and EconoKote

flight performance

TAKEOFF AND LANDING

With the wide stance of the landing gear, the Rapture needs very little right rudder to track straight. It does need a little up-elevator to hold the tailwheel on the ground until the rudder becomes effective. After about 60 feet, I added more up-elevator. The Rapture rotates on its mains and lifts off nice and easy.

Setting up for landing on the downwind approach, I cut to ½ throttle; then, after turning into the wind, I cut the throttle to idle and advanced it about three clicks. By doing this, you'll keep up your flying speed on windy days. As most of us in this hobby know, a landing is nothing more than a controlled crash; the Rapture is, however, a joy to land. When the plane is lined up with the runway, the 60-inch-span wing keeps the plane level and needs very little input on the ailerons. Once over the runway, I cut the throttle to idle, and the bird just settles in. The elevator and ailerons are effective right down to landing.

LOW-SPEED FLIGHT

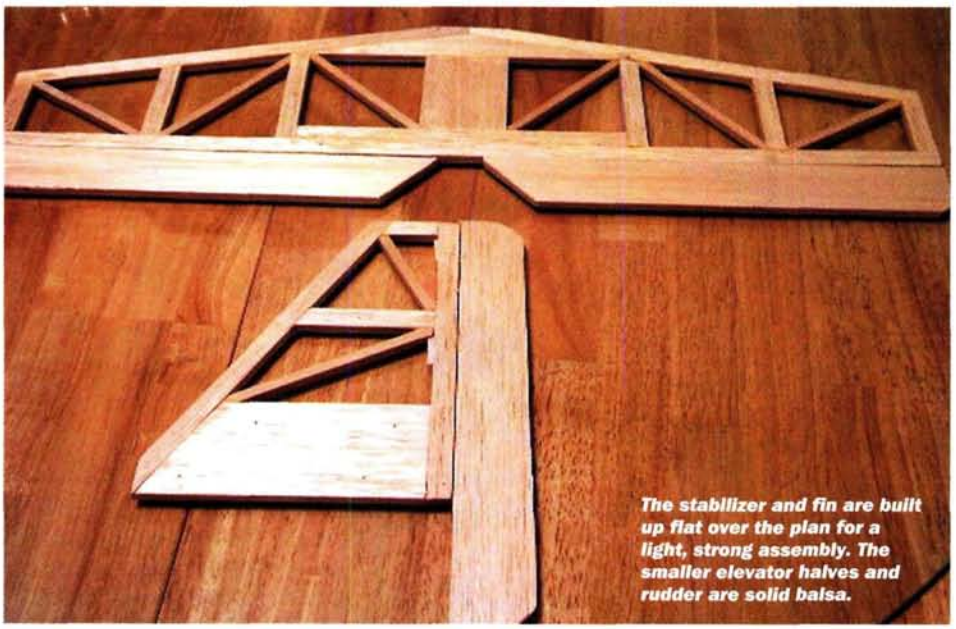
When I cut the throttle to idle, the Rapture just kept flying; the nose dropped just a little, but there wasn't any tendency to tip-stall, and with a little wind, you could probably hover. At ¼ throttle, the Rapture is very stable, and when trimmed properly, is very relaxing to fly; in fact, you could probably sit in a chair and fly this plane all day.

HIGH-SPEED FLIGHT

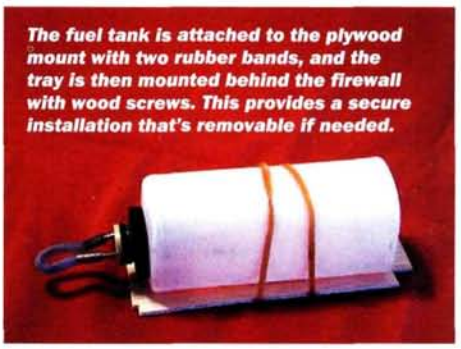
The Rapture really moves out! Vertical performance is good with the Magnum .46. Pull straight up from level flight, and the plane climbs for about 150 feet before it falls out. The turns are very smooth, but it needs a little elevator to stay level. It's a good fit for a pilot who's looking for the next step up from a trainer.

AEROBATICS

Loops are nice and round with very little rudder needed to track straight. Rolls are smooth and crisp, and inverted flights are easy with very little down-elevator needed for level flight. The Rapture is even capable of flying knife-edge, which really surprised me, as the rudder is not very large. The Rapture can do more than enough aerobatics to satisfy the newer pilot.



The stabilizer and fin are built up flat over the plan for a light, strong assembly. The smaller elevator halves and rudder are solid balsa.



The fuel tank is attached to the plywood mount with two rubber bands, and the tray is then mounted behind the firewall with wood screws. This provides a secure installation that's removable if needed.

for the trim. Great Planes devotes two pages of the manual to covering the plane.

When you've covered everything, assemble the model by gluing the stabilizer and rudder into place and installing the radio and motor. The engine is mounted upright between two cheek cowls for ease of fueling. I installed a Magnum XL46 and four Airtronics 94102 servos.

Once you have completed the model, you set the controls. The engineers at Great Planes recommend the following for low rates:

- elevator—⅜ inch up and down
- rudder—¾ inch left and right
- ailerons—⅜ inch up and down

High-rate recommendations are:

- elevator—½ inch up and down
- rudder—1 inch right and left
- ailerons—½ inch up and down

If your radio does not have high and low rates, use the low rates for your initial flights. You can use Great Planes AccuThrow or a ruler to set the throws. The company spent a lot of time and money researching this design, so please do not skip this step.

The next important step is to balance the model. I used a Great Planes CG Machine. Great Planes recommends that you balance the Rapture 3¼ inches back from the wing's leading edge. Even after moving the battery pack as far forward as I could get it, I had to add 1½ ounces to the nose to get the correct balance. That brought the weight to 5 pounds—right in the middle of the 4.5- to 5.25-pound recommended weight.

BUILDER'S THOUGHTS

Great Planes emphasizes that the Rapture 40 features simplified building techniques, and I agree. There's no worry about flaps or retracts; sheeting is used sparingly, and the die-cutting is very accurate. I took only four weeks to get this model ready to fly. Anyone who's looking for a low-wing aerobatic model that's very stable and easy to build should definitely check out the Rapture 40. The folks at Great Planes have done themselves proud with this kit, and at a price of $94.99, you can't beat this deal. ✚

Airtronics *(714) 978-1895; airtronics.net.*
Coverite; *distributed by Great Planes.*
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Great Planes Model Distributors
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Magnum; *distributed by Global Hobby Distributors (714) 963-0329; globalhobby.com.*
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HIROBO

Long Ranger

BY RODNEY ROY

Melding form and function

In addition to manufacturing world-class aerobatic helicopters, Hirobo offers an exciting line of scale helis. It has some of the most complete scale kits on the market; they include the mechanics, a high-quality fiberglass body and scale details. Recently, Hirobo decided to try a different approach in the scale market by offering painted fuselages designed expressly for its Sceadu line of helis.

In the April 2004 issue of *Model Airplane News*, I reviewed the .50-size Hirobo Sceadu, and during the past few months, the heli has proved itself to be one of the best choppers I've ever owned. It's very reliable and easy to maintain, and most important, it flies great. I'd been wanting to try my hand at changing a pod and boom into a scale-looking heli but had heard that building and maintaining one could be tricky, so I didn't pursue this interest—until now.

In the Hirobo booth at the 2004 Westchester Radio Aeromodelers (WRAM) show in White Plains, NY, I spied a very sharp-looking Long Ranger. Its bodywork and paint were flawless and really caught my eye. I used to repair and paint auto bodies for a living, so my interest was piqued. I asked about the heli and was floored when I found out that the model on display was not a one-off custom model but a standard offering. Needless to say, my interest in scale was renewed.

FIRST IMPRESSIONS

Opening the box of a new kit is always exciting, and knowing what was inside this box made my anticipation run high. There isn't much to the kit, but what is there is fantastic. It's constructed of fiberglass, is very light and comes in two parts: the main body and the front cabin. I was extremely impressed, as there weren't any mold seams, and the paint was impeccable. With the exception of the white, the colors are metallic, and the entire body has been clear-coated for protection. The horizontal and vertical fins are also fiberglass and painted to match. Fuselage cutting is minimal: the windows, the mounting holes and the cutouts have been finished for you (all except an exhaust outlet).

Also in the kit are miscellaneous nuts and bolts, a painted fiberglass tail cone, a hard foam-rubber tail-boom insulator, detailed drawings and the front windshield, which is already trimmed and painted. Even the screws that attach the tail cone are painted! The workmanship is just outstanding, and to say I was impressed would be an understatement.

ASSEMBLY NOTES

I could see that Hirobo has made converting a pod-and-boom heli into a full-body one a simple exercise. As mentioned, the fuselage is configured so that the entire

***Above:** before you glue the painted parts in place, the gluing surfaces should be thoroughly scuffed for a secure bond. **Below:** plywood spars support the horizontal stab, and they are epoxied inside the fuselage's tail boom.*

front cabin is removable. This makes installing and maintaining the mechanics pretty easy. They are bolted to the bottom of the fuselage, and the landing gear sandwiches the body between them; two body stays attach the upper portion of the body to the chassis. The tail boom is supported at the rear of the body with a tightly fitting, hard foam-rubber insulator that keeps it centered in the body and soaks up vibrations.

When you conceal helicopter mechanics in a full body, two items need to be figured out: fueling the model and lighting the glow plug; access to these is limited. For fueling, I inserted a T-fitting in the fuel line with a line off the center nipple that's capped during flight. To fuel the model, I clamp off the line to the carb with a set of hemostats, and then I fuel the model as I usually would; simple and easy. To light the glow plug, I needed a remote plug adapter, and Hangar 9 makes a very good one (item no. HAN3025). It attaches to the plug and has a remote connector to which a separate mini-phono jack is connected and energizes the plug.

In this conversion, the most important part is the flybar tilt limiter—a small, hard plastic ring that slides on the main shaft and seats against the bottom of the main rotor's center hub. As its name implies, it limits how far the flybar assembly can tilt during flight. I didn't understand its use until I had installed the mechanics in the fuselage; it then became perfectly clear.

FUSELAGE AND CHASSIS PREPARATIONS

This is the first time that I have worked on a project like this, and much to my

specifications

MODEL: Long Ranger

MANUFACTURER: Hirobo

DISTRIBUTOR: MRC

TYPE: scale helicopter

ROTOR DIAMETER: 53 in. (1,348mm)

LENGTH: 50 in. (1,270mm)

HEIGHT: 17¼ in. (435mm)

WEIGHT: 8 lb. 5 oz.

RADIO REQ'D: 5-channel heli radio

RADIO USED: JR 10X transmitter, 4 JR DS8231 digital servos, 1 JR NES4131 servo and JR 450 gyro

ENGINE REQ'D: .50 2-stroke heli

ENGINE USED: O.S. 50SX-H

FUEL USED: Wildcat 30% heli

PRICE: $550

FEATURES: painted fiberglass fuselage, tail fins and tail cone; 2-piece fuselage configuration; miscellaneous screws, nuts and bolts; trimmed, fitted and painted windshield; instructions.

COMMENTS: the Hirobo Long Ranger is a class act all the way. It's easy to assemble and maintain, and the quality of its painted parts is, in a word, awesome! When flying, the heli takes on a whole new personality yet retains most of its aerobatic prowess. The Long Ranger/Sceadu is a winning combination!

HITS

- Outstanding workmanship.
- Easy assembly.
- Beautiful paintwork.
- Looks great in the air!

MISSES

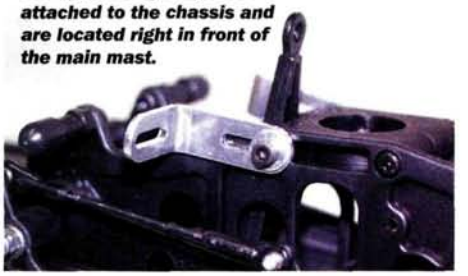
- Body-mounting flanges too short.

surprise (and relief), the transformation went without a hitch and took me only about five hours. It certainly can't get much easier than that!

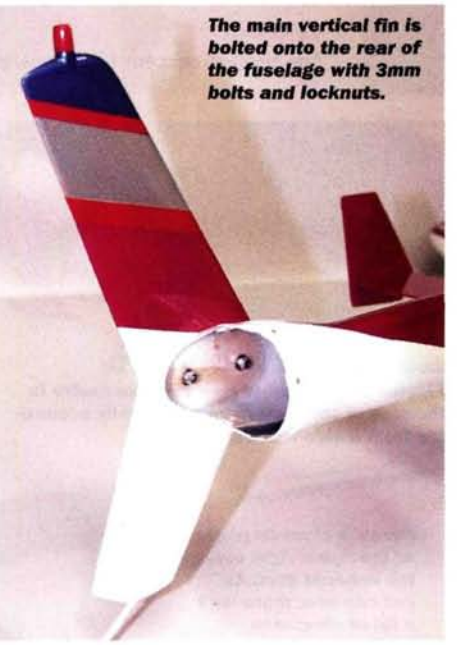
To install the mechanics in the body, you need a few hand tools and epoxy. The most exotic tool was a Dremel Moto-Tool, which I used to cut an opening in the bottom of the body for the exhaust outlet. Minor disassembly of the chassis is required to prep it before inserting it into the fuselage. Remove the tail fins, boom supports, tail-rotor assembly, body mounts, main mast and rotor head and landing gear, and set them aside. I capped the end of the tail boom with a piece of tape to prevent the drive belt from falling inside it. I also thoroughly cleaned and inspected the mechanics to make sure that everything was in good working order.

Next, I epoxied the scale exhaust duct, horizontal stab and vertical fins to the fuselage. Before doing this, I used a sanding stick to scuff the painted surfaces to be glued to ensure a secure bond. The stabilizer is hollow fiberglass as are the vertical fins, and they are keyed to one another for a precision fit. Plywood spars glued to the fuselage also support the stab, and the entire assembly is very rigid. The main vertical fin is attached to the tail boom with two 3x20mm bolts and locknuts. The windshield is trimmed and painted and only has to be glued to the front cabin. I outlined the windshield and its recess in the cabin with tape and then applied a thin bead of glue around both. The tape prevents the glue from getting on the glass and body (where it shouldn't be).

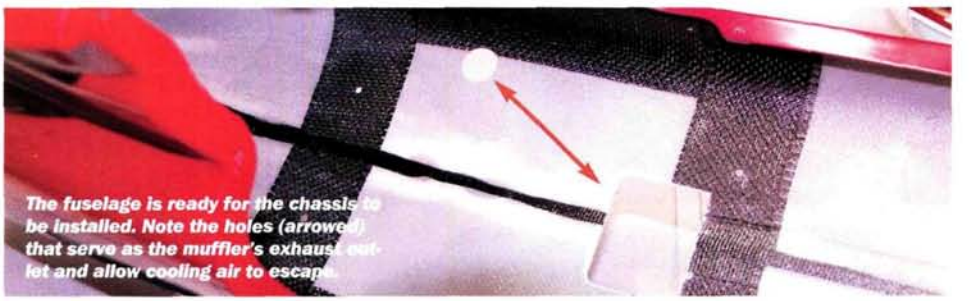
The stab slides over the spars and is epoxied into place. Below: after the stabs have been secured, the vertical fins are epoxied in place.



The upper body stays are attached to the chassis and are located right in front of the main mast.



The main vertical fin is bolted onto the rear of the fuselage with 3mm bolts and locknuts.



The fuselage is ready for the chassis to be installed. Note the holes (arrowed) that serve as the muffler's exhaust outlet and allow cooling air to escape.

INSTALLING THE MECHANICS

With the fuselage prepped, I installed the chassis to determine where I should cut the exhaust outlet for the muffler. Using the Sceadu's kit-supplied muffler, I could see that its outlet would protrude slightly through the bottom of the fuselage. I removed the rear half of the muffler so that the chassis would rest flat on the inside of the fuselage. I held the muffler in place and made a mark where the outlet had to be. Next came the scary part: cutting a hole in this beautiful fuselage exactly where it needed to be! I started by making a small hole with a Dremel tool, and I enlarged it slowly until it could accommodate the muffler's outlet and a Du-Bro exhaust diverter.

With the exhaust opening out of the way, I slid the chassis as far back into the fuselage as I could so that I'd be able to reattach the tail-rotor assembly to the tail boom. Before you do this, be sure to slide the tail-boom insulator onto the tail boom. The long notch in it faces downward and provides clearance for the pushrod. I then pulled the chassis forward and bolted it and the landing gear to the fuselage.

The next task is to attach the upper body stays to the chassis and the body, and here, I ran into a slight problem: the stays are supposed to be attached with 3mm bolts and locknuts to a fiberglass flange in the body, but the flange wasn't wide enough for the stays to reach. To get around this problem, I epoxied and bolted a couple of pieces of plywood to the flange and then bolted the stays to the wood.

With the chassis and fuselage firmly tied together, I removed the main rotor head from the mast and installed the flybar tilt limiter on the shaft. Be sure to slide it on so it is seated against the bottom of the main rotor hub, and you have enough clearance to reinstall the jesus bolt. I put the rotor head back on the mast, installed the assembly in the mechanics and then rotated the head. It was immediately clear why the flybar tilt has to be limited. If it isn't, as the flybar spins, it will hit the scale exhaust duct (it's a very simple, clever way to avoid having a problem without using a longer mast and pushrods).

flight performance

Because the heli has been flown many times in its pod-and-boom configuration, we didn't anticipate any problems while flying the Sceadu with the Long Ranger body attached to it.

HOVERING

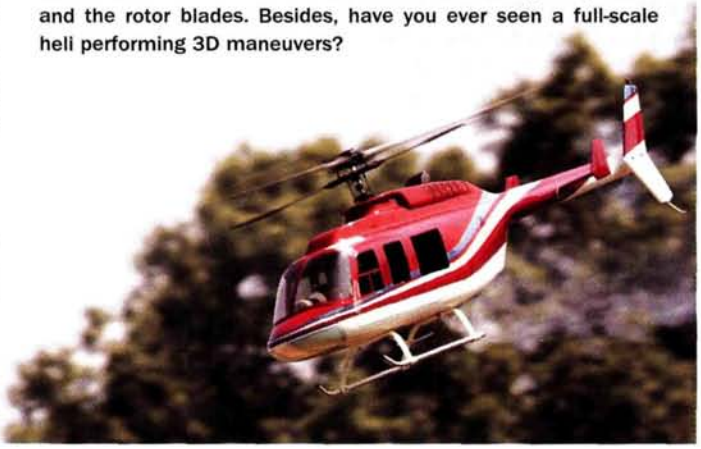
Hovering flights take on a different look with the full fuselage. Orientation of the heli is a lot easier, and the multicolored paint scheme gives many visual clues as the heli moves about. The overall hovering characteristics of the heli are a little more solid, thanks to the additional weight of the body. The only time you really notice a major difference is when hovering in a crosswind; the increased side area of the body causes the heli to react more interactively with the wind.

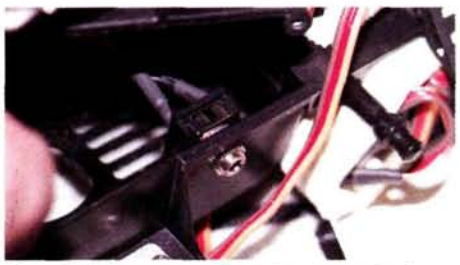
FORWARD FLIGHT PERFORMANCE

In its pod-and-boom state, the Sceadu tracks very well in forward flight. With the body attached, though, forward flight characteristics are improved even further as the heli is much more aerodynamic and slippery. Top speed is also noticeably increased.

AEROBATICS

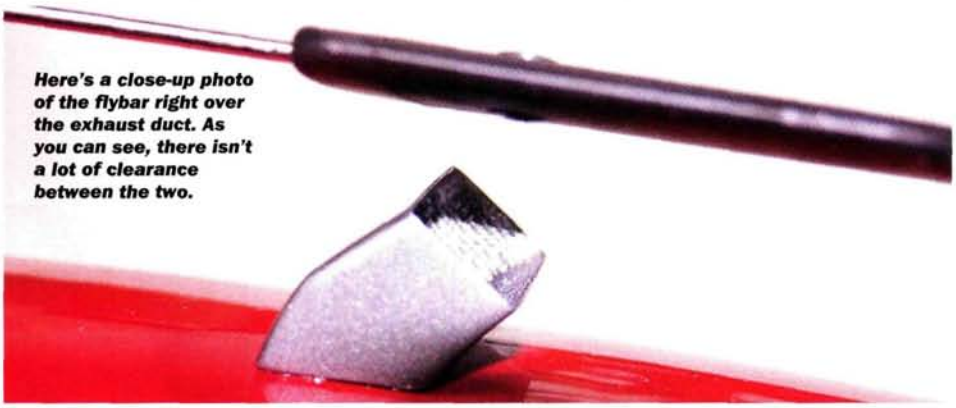
The biggest concern I had was the flybar tilt limiter and how it would affect the heli's agility. Hirobo also recommends that you don't exceed 1,800rpm with the main rotor. Much to my surprise, its capabilities were affected very little. Basic aerobatics such as loops and rolls were possible, albeit at a slower pace, but they were still very graceful. Aggressive 3D aerobatics such as flips and tumbles aren't really possible because the flybar tilt limiter diminishes the interaction between the flybar paddles and the rotor blades. Besides, have you ever seen a full-scale heli performing 3D maneuvers?





I installed the remote glow-plug connector in the side of the battery box; it's easily accessible from a side window.

There's plenty of room to reinstall the tail-rotor assembly on the tail boom when the chassis is in the fuselage.



Here's a close-up photo of the flybar right over the exhaust duct. As you can see, there isn't a lot of clearance between the two.

The black plastic ring on the hub is the flybar tilt limiter. It's very important to install it to prevent the flybar from hitting the scale exhaust.

With the front cabin removed, there's plenty of room to work on the mechanics.

FINAL ASSEMBLY

Four locating pins and several self-tapping screws hold the front cabin in place. The mating holes for the pins were a little on the tight side; a few passes with a file worked quite well to loosen them up. After you've put the screws in and out a few times, harden the plywood pads with a few drops of thin CA. When I mated the cabin to the fuselage, the paint trim lines matched up perfectly. Very impressive! The last part to attach to the heli is the tail cone, and it's screwed into place with the painted screws. No decals are provided in the kit, as none are required.

SUMMARY

I must say that Hirobo has a winner on its hands with the Long Ranger fuselage. Transforming the Sceadu from a pod-and-boom configuration into a full-blown scale beauty was far easier than I thought it would be. The quality of the fiberglass fuselage is of the highest order, and the paint is spectacular, especially when lit by bright sunlight. Access to the mechanics is well thought out, and the heli is easy to maintain. If you're looking for an easy way to try your hand at a scale helicopter, this is it!

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by Quique Somenzini

3D Aerobatic Setup

Instead of explaining how to do a 3D maneuver, I decided that this time around, I'd describe the setup of my airplanes. The mechanical setup is the foundation from which a great flying model starts. The 3D flight mode is probably the simplest mode to set up. Why? Because in order to perform the full range of 3D maneuvers, the airplane must have the control surfaces move to their maximum travel. That's when different flight modes or dual rates become so important. When the control surfaces move to extreme throws, it's nearly impossible to fly smoothly and precisely at high speeds. So when you use dual rates or—even better—a dedicated flight mode, you can easily adjust the airplane for different flight realms, e.g., precision or 3D aerobatics.

MY TECHNIQUE

To have the very best setup for 3D, you must think about it from the beginning. When I design and build my airplanes, I work the setup into the construction process. Most of you will never design a dedicated 3D airplane, but most likely, you will assemble the latest 3D "whiz-bang" and install the radio system, control horns, etc.

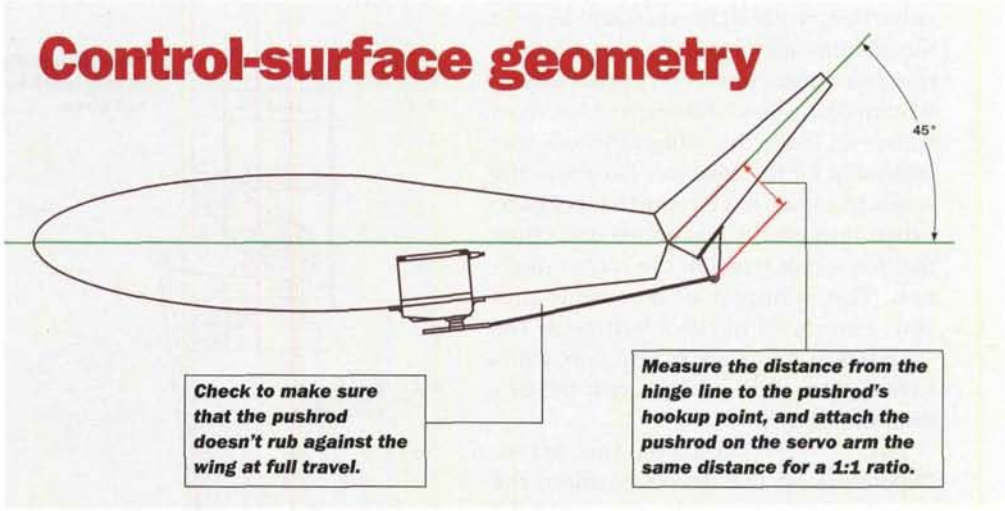
The "soul" of 3D is making sure that the servos travel to their maximum to provide a minimum of 45 degrees of control-surface (aileron, elevator, rudder) movement—especially the elevator.

First, you need to verify that the control surfaces can deflect 45 degrees; if they can't, you must correct that. If the rudder or ailerons deflect only 35 degrees, that should be OK (it really depends on the airplane's design, though), but most airplanes require a minimum of 45 degrees of elevator travel. On my airplanes, I like the control surfaces to have around 55 degrees of travel. Next, make sure that the clevis is attached to the control horn directly over the hinge line. This important step ensures that the control surfaces travel equally on both sides of neutral. This is also very helpful for when you use a pull-pull cable system on the rudder because it helps the cables remain tight as

they travel from one extreme to the other. When you program the radio for maximum servo travel, the servo arm should travel 60 degrees to each side. You'll understand later why this is important.

Next, I check how long the control horns need to be when the control surfaces are deflected at 45 degrees. I also make sure that the pushrod(s) don't touch or rub anywhere along the length of the wing (see "Control-surface geometry" illustration). Check the distance from the hinge line to the hookup point on the control horn. This measurement is an excellent reference to help you choose the correct servo-arm length. For example, if the measurement at the control horn is 1½ inches and you use a servo arm that's 1½ inches long, then the control surface will be deflected 60 degrees to each side. This 1:1 ratio method is a very simple way of determining servo-arm length. If you have too much deflection, move the clevis (in) closer to the servo output shaft. When you move the clevis inward, you'll gain better resolution and more torque. You might need to do a few tests until you have the throw you want.

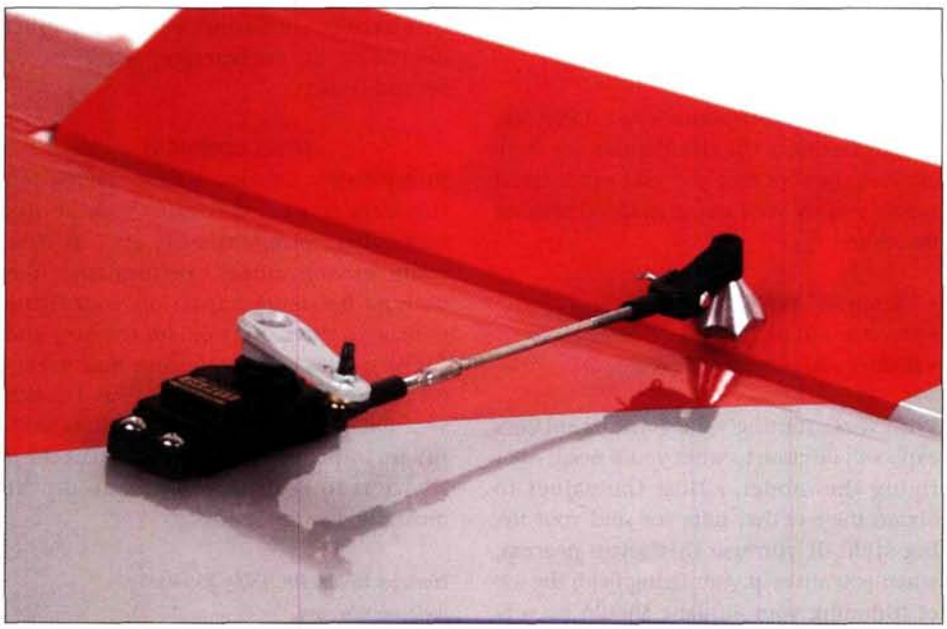
The control horn's location on the control surface in relation to the servo is very important. A popular setup is to have the pushrod at a 90-degree angle on the servo arm when the servo is centered. This is wrong! When the servo arm travels from one extreme to the other, the pushrod moves in an arc, and with the 90-degree angle, the servo will be pulling the surface control more than it will be pushing it. If this were the aileron servo, you would have to adjust the servo travel to have the same degree of aileron travel up and down, and this most likely would result in less servo travel. The same would happen with elevator. To avoid this problem, the control horn must be placed in toward the servo centerline (see "Control-horn placement" illustration). As you can see, when in this position, as the servo arm reaches its maximum travel, the pushrod is parallel to the servo's centerline. This setup allows the control surface to travel the same amount when the servo travels to either extreme.



THE CONTROL HORN'S LOCATION ON THE CONTROL SURFACE IN RELATION TO THE SERVO IS VERY IMPORTANT.

Another way to compensate for the servo arc is to offset the servo arm at its neutral position. This way is OK, but it might take you more time through trial and error to find the best angle. If you can't relocate the control horn, your best option would be to offset the servo arm.

Here's a detail that many modelers overlook: when you use more than one servo per aileron or elevator, the height of the control horns will vary as the aileron or elevator tapers (thins) towards the tip. You must adjust each pushrod's height by measuring from the hinge line—not from the control surface. As the control surface tapers, the pushrod will appear to be higher, so don't be fooled.



This is a typical 90-degree control-horn setup. Notice that the control horn could be moved in toward the servo's centerline for more precise control.

HOOKING UP THE CONTROL SURFACES

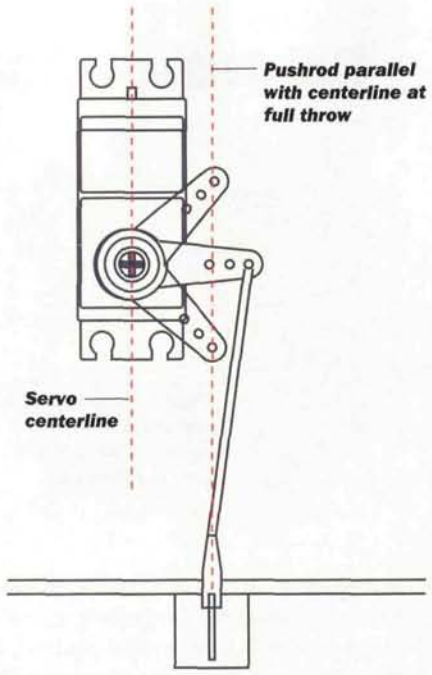
When you've accomplished all of the above, use a piece of clear UltraCote to seal all the control surface's gaps from the bottom. This makes the model look better, but more important, sealing the gaps helps the control surfaces be more effective as well as have the same feel (left and

right, up and down); this is very important for ailerons.

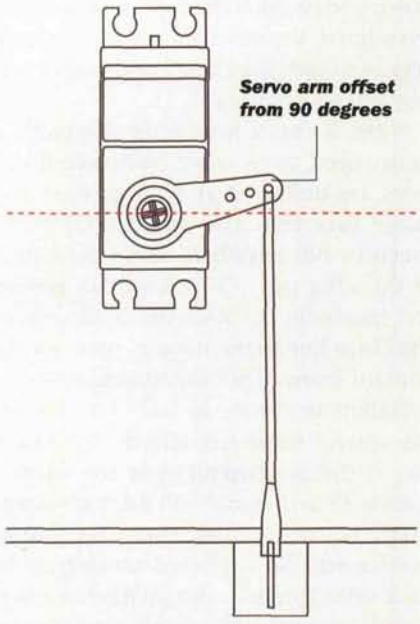
Now we can start to hook up the servos to the control surfaces and program the radio. First, center all the trims and zero out the subtrims. It's important to keep the subtrim percentages small; every percentage of subtrim that is used will result in less servo travel. To make the setup process easier (especially for the ailerons), I connect the servos to a spare receiver and battery pack. I then turn on the transmitter and check that the servos travel in the correct direction. This is important because if after you've made all of the adjustments the servo travels in the wrong direction, you'll have to start over—particularly if the subtrim was used.

Put a servo arm on the servo. Depending on the servo's position, the arm should be perpendicular or parallel to the servo's main axis (centerline). If the arm is slightly off center, adjust that with subtrim. Connect the pushrod to the servo and the control surface, and then adjust the pushrod's length until the control surface is exactly at neutral. Max out the servo-travel function (ATV) as well as the rate to 100 percent, and then move the stick slowly and make sure that the servo can move freely from extreme to extreme—if it can, that's great! Check how much the control surface deflects and adjust as necessary. Follow this process with each servo and control surface.

Control-horn placement



By positioning the control horn toward the servo's centerline, the control surface will move equally in both directions.



If you can't relocate the control horn, offset the servo arm to achieve the same effect. You'll have to experiment for the best results.

WITH THESE STARTING VALUES, YOUR AIRPLANE'S EXPO WILL BE CLOSE TO WHAT YOU'LL NEED.

If you use more than one servo per control surface, I strongly recommend that you use a JR MatchBox to properly adjust the servos. The MatchBox allows you to individually adjust the servos so that they will have the same travel and neutrals. Adjusting multiple servos on a single control surface can be a real challenge, and the MatchBox greatly simplifies the process.

This is when I mount the wing on the fuselage, put the airplane on its wheels and do a general check. I make sure that the ailerons are moving the same amount (up and down), and I do the same for both elevator halves. When completed, the 3D setup of your airplane is ready for flight-testing, and you'll have reached the goal of optimizing your plane for 3D maneuvers.

About programming the transmitter: if your radio has only dual rates, set the high rate as your 3D mode. If your radio has programmable flight modes, choose one and name it as your 3D mode. See my "Flight Mode" article in the February 2004 issue of *Model Airplane News*. One last detail: because the 3D throws are very extreme, be sure that you add exponential before you fly your airplane. Good starting values are:

- Aileron +60 percent
- Elevator +70 percent
- Rudder +30 percent

With these starting values, your airplane's expo will be close to what you'll need. After flying the model, adjust the values to obtain the feel that suits you and your flying style. If you use this setup process, when you arrive at your flying field, the job of trimming your airplane should be very simple and will mostly be limited to adjusting the exponential values.

LANDING/EMERGENCY MODE

I like to set up a flight mode as my "landing" or "emergency" mode. This means that by using a single switch, the airplane will have a normal setup for landing. It should be easy for you to access the switch that this mode is set up on, and that setting should cancel all other flight modes. I have found that this avoids confusion when you must deal with an emergency, when every second counts.

FINAL COMMENT

In my recent articles, I have spelled out the importance of flight-mode setup, transmitter programming, etc., as they relate to your model's performance. But nothing has more impact on your flying than you, the pilot. You are the key, and flight modes, programming and everything else are there to help you! Though you may find all of this information helpful in improving your skills, the best advice is to do what you like to do the most: fly, fly, fly. Enjoy! +

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DH MOSQUITO

by Mark Rittinger

A killer twin-electric WW II fighter

The de Havilland Mosquito, affectionately known as the "Mossie," was a unique WW II twin-engine, day- and night- fighter/bomber. It was constructed primarily of wood, and it was powered with twin Rolls-Royce Merlin engines. Four .303-caliber machine guns and four 20mm cannon made up its armament.

Throughout the War years, the Mossie fulfilled many roles, such as fighter, bomber, recon and patrol aircraft, and it was finished with wildly varying color schemes, from all black and all yellow to simple silver and, of course, typical camouflage schemes. The model presented here can be built as many variants. The wingtips could even be extended to create the NF Mk. XV high-altitude fighter.

Fuselage construction begins with assembling the sides, formers, stringers, longerons and the lower-corner tri-stock material. Former F2 has not yet been installed.

specifications

MODEL: de Havilland Mosquito

TYPE: twin electric

WINGSPAN: 44 in.

LENGTH: 34 in.

WEIGHT: 35 to 40 oz.

WING AREA: 352 sq. in.

WING LOADING: 16.36 oz./sq. ft. @ 40 oz.

RADIO REQ'D: 3-channel (aileron, elevator, throttle; rudder optional)

MOTORS USED: Graupner Long-can Partenavia Power Pack Speed 480s

PROPS USED: APC 5x5 and 6x4

BATTERY USED: 8, 800AR Ni-Cd cells

COMMENTS: designed by Mark Rittinger, the D.H. Mosquito is a great-flying sport-scale twin electric-powered WW II British multitask fighter. It features all balsa and ply construction and is a one-piece design; the wing does not come off.

THE MODEL

I simplified the complex fuselage shape by making it flat on the bottom while retaining a scale profile. The outlines are accurate, however, so it looks unmistakably like a Mosquito in the sky! Do not be afraid of the tiny wingtips and scale control surfaces; it's a fine flying machine as is. The plans include two nacelle options: one is for the popular Graupner high-speed Speed 400 spinner, and the other uses a common, more scale sized 2-inch spinner.

This close-up shows the simplified flat-sided fuselage structure.

The model is built mostly of 1/16- and 3/32-inch balsa. Some of the construction might look a bit flimsy, but when complete, the Mossie is very strong and holds up well. The model shown under construction was built by David Jenista, and I thank him for the fine job he did.

BUILDING THE MOSSIE

Photocopying the plans will allow you to transfer them to the wood. Place the copies face down on the wood and rub the back side of the copy with a rag and some acetone; this will transfer the copier toner onto the wood. Start construction with the fuselage. The fuselage formers are laminated to create light but very strong bulkheads. Laminate the wood as shown on the plans, and then cut the parts out.

Frame up the fuselage with all the bulkheads, square stringers, longerons and tri-stock corners, but don't install former F2 yet. Glue the 1/16-inch doublers in the wing-saddle area, and make sure that the fuselage is straight before sheeting it. Cut out the fuselage sides from 1/16 balsa sheet, and leave enough material on the top to allow for the curvature over the deck.

When you are sure things are straight, glue the sheeting to the sides of the fuselage frame. As this model is one piece, do not glue the sheeting over the top deck until the wing has been fitted into place. Next, sheet the bottom of the fuselage, and then set it aside and begin on the wing.

THE WING

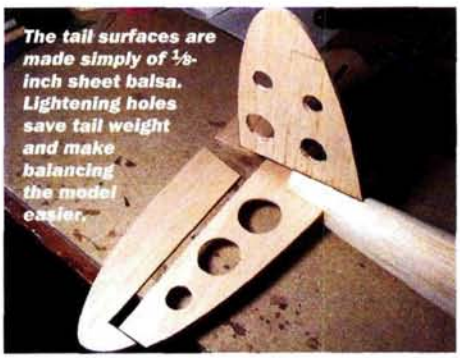
The wing uses a simple, fully sheeted, flat-bottom design with an 1/8-inch main spar. Build each wing half, and then join them and add the top sheeting. Begin building the wing by gluing together edgewise enough 1/16 balsa for the bottom skins. I prefer using aliphatic glue, as it sands better than CA.

Pin the bottom skin to your board. Cut the ribs out of medium 1/16-inch balsa, and mark the spar location on them (see wing top view). Cut the ribs in two at the spar location. Cut the main spar for each panel out of hard 1/8-inch balsa, and cut the sub-spars using the full main spar as a template. To route the servo and motor wiring, remove the material between the two spars from ribs 1, 2 and 3.

Glue the spars and the ribs to the bottom sheeting, and cut off the aft parts of ribs 5, 6, 7 and 8 at the aileron section. The ribs should be 1/8 inch short of the aileron hinge line to allow for the 1/8-inch balsa facing in front of the ailerons. Use a long sanding stick to sand the facing to match the height of the ribs.

Install your 1/4-inch-sheet leading edge, and pay close attention to the inner leading-edge placement between the nacelles. Sand the leading-edge top to shape where the top sheeting will be glued. Cut the center doublers out of 1/8-inch ply or very hard balsa. With both bottom wing panels done, pin one to the board and block up the other tip 2 inches; then glue the

Fuselage with aft-deck sheeting and tail surfaces attached.



The tail surfaces are made simply of 1/8-inch sheet balsa. Lightening holes save tail weight and make balancing the model easier.

flight performance

TAKEOFF AND LANDING

With the motors running, check your Mossie for range and possible interference. Also, before its first flight, check the control surfaces for proper deflection amounts and directions. Since this is a hand-launched model, there is no real takeoff. Simply hold the model overhead and point it into the breeze with its wings and nose level, and then give it a good, solid toss! The model climbs in a very scale-like fashion and may require slight trim adjustment to fly straight and level.

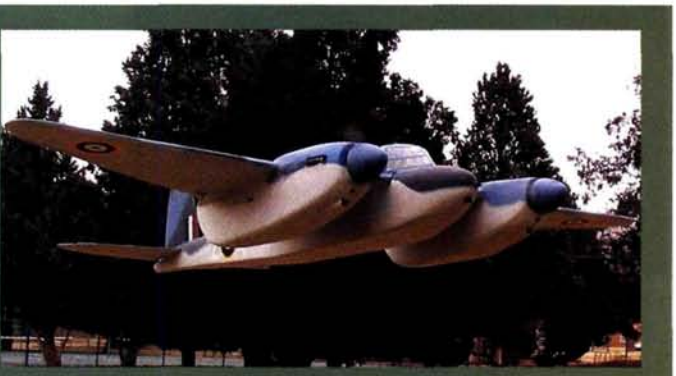
Do a dry run at a safe altitude to check your model's sink rate before actually coming in to land. When you feel comfortable, line it up on final and cut the power. The Mossie glides well and will belly in for landing on its engine nacelles and fuselage. Despite the tiny, scale wingtips, the model doesn't show any tendency to tip-stall (as long as you don't fly it too slowly!).

SLOW-SPEED PERFORMANCE

If built light, the Mossie will fly at very slow speeds. Control is good right up to the stall point. When they occur, stalls are abrupt, so be prepared for them if you are flying low and slow.

HIGH-SPEED PERFORMANCE

The plane has a good, wide flight envelope, and the high-speed flight looks great. (Just like the full-size!) I estimate the top speed to be around 50mph. Control is crisp, and it tracks well. I love those low-altitude, high-speed passes.

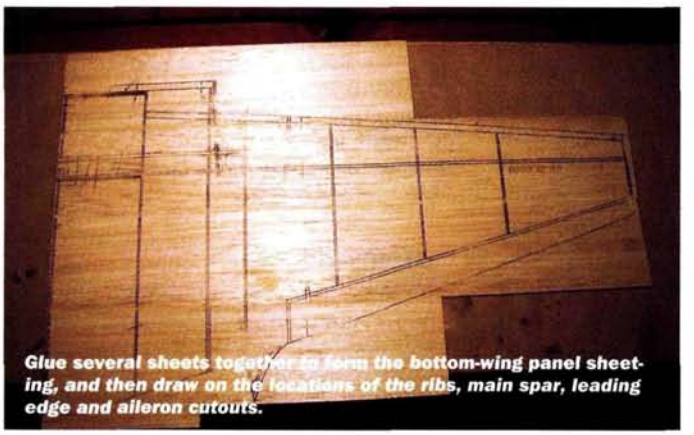


AEROBATICS

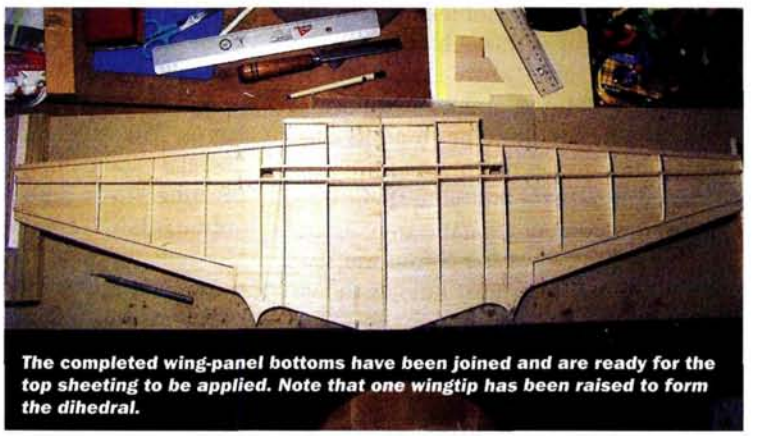
Any aileron/elevator routine can be flown with the Mosquito. Rolls are nice, and loops can be fairly large. If you add a rudder, you can do even more maneuvers, but I doubt that the full-size aircraft did too many flat spins!

Inverted performance (with the proper CG position) is good. Slow rolls can still be done without rudder due to the side areas of the nacelles and the fuselage.

All that's missing is an FW-190 and an Me 109 to chase! Credit for building and flying the models shown in this article goes to both Jim Best and David Jenista.



Glue several sheets together to form the bottom-wing panel sheeting, and then draw on the locations of the ribs, main spar, leading edge and aileron cutouts.



The completed wing-panel bottoms have been joined and are ready for the top sheeting to be applied. Note that one wingtip has been raised to form the dihedral.

doublers into place. At this point, I usually install a string inside the wing to pull the motor wires through. Make the washout guide out of 1/8-inch balsa and place it under the tip pinned to the building board. Cut your top sheeting slightly oversize to allow for the curvature of the wing, and glue it to the panel pinned to the board.

Remove the wing from the board and do the same for the other wing half. Make sure that you have a nice, tight fit along the top-sheeting centerline joint. You should end up with 1 inch of dihedral under each wingtip.

Cut a hole in the center of the wing's top sheeting between the two spars to pull the wires through. Wrap the wing's center with nylon or fiberglass cloth and glue it into place with thin CA. Glue the wingtips into place, and sand them and the leading edge to match the plans. I made my ailerons from preshaped aileron stock cut to shape and sanded to fit.

WING TO FUSELAGE JOINT

After the wing has been completed, you can join it to the fuselage. Carefully slide the wing into the fuselage's wing cutouts. Do not force it in! If the fit is very tight, trim a bit off the cutout. Once the wing fits properly and slides all the way in, check the fuselage and wing alignment and glue the wing into place. Now add former F2 and glue it on top of the wing.

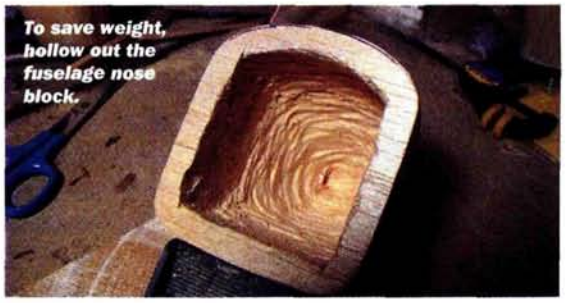
Wet the outside surface of the fuselage's top sheeting that bends over the deck to help bend it to shape. Mark the location of the center top stringer on one side of the sheeting and glue it down. Then do the same for the other side. Add your nose and tail cones, and give the whole fuselage a good sanding. Cut a slot in the rear of the fuselage for the 1/8-inch sheet stabilizer and glue it into place. Now cut the slot for the fin and glue it into place being sure to glue the base of the fin to the stabilizer inside the fuselage. Make sure that everything is square and true before gluing. A functional rudder could be added but is not needed for flight.

ENGINE NACELLES

Here, I provided two choices. The model flies equally well with either spinner, so the choice is yours. The nacelles are fairly simple. The sides are cut out of 1/16-inch medium balsa, and the framework is made mostly of 1/8-inch-square stock. Make the four sides, and glue the 1/8 framework to the inside surfaces. There are no bulkheads—only 1/8-inch-square longerons near the leading edge of the wing and 1/8-inch ply motor mounts/firewalls. I suggest gluing the motor mounts and 1/8-inch crosspieces to the side first, and then pulling the rear ends together.

Attach the motors to the firewalls before installing them in the nacelles to make sure that they line up correctly with the spinners. The "Long-can" Partenavia


The bottom nacelle blocks should be made of balsa for strength.


To save weight, hollow out the fuselage nose block.

Power Pack Speed 400 motors sold by Hobby Lobby and the Max 48s from Dymond Modelsports work better than stock Speed 400 motors. Twin Speed 480s would also work, as would twin brushless motors. In true Mossie fashion, the prototype performs with the "Long-can 400s" just fine.

The top nacelle blocks can be made of foam, but the bottom ones must be made of balsa to provide the necessary strength. I suggest adding the top blocks after fitting the nacelles to the wing; that makes it easier to get a good fit. The aileron servos are placed inside the nacelles, so cut the servo-arm slots on the outside of the nacelles and install the servos with double-sided servo tape. Coat the wood where the servos will be attached with CA or epoxy to make a better surface for the tape to adhere to. Position the nacelles on the wing, connect the servo Y-harness and glue them into place using epoxy or aliphatic glue. Again, make sure that everything is true and that you set the nacelles' thrust lines as shown on the plans.

The bottom fuselage hatch can be cut out before or after covering. You can mold your own canopy, or you can make it by splitting a WW II-style canopy down the center and adding acetate to create the correct look and width.


The large battery hatch in the bottom of the fuselage can be made before or after covering.

RADIO AND COVERING

Any 3-channel radio will work well. Install all radio gear before you cover the plane so you won't get hangar rash (as I did). Install the elevator servo toward the rear of the wing, and then place the receiver in front of it and the ESC in front of the receiver. Use a 30A or larger ESC with a battery-eliminator circuit suitable for three servos. The Mossie can be finished with fiberglass and painted, but I suggest a film covering. If you are going to add a weathered finish, remember, the full-size Mosquito was made of wood—not metal!

You can use any 9.6V Ni-Cd, NiMH, or Li-poly pack. I have used everything from eight 800AR cells all the way up to eight 1300CP cells, as well as 2000 NiMH cells. Just be sure that the packs you use can handle a 30A draw for 4 to 5 minutes. If you use Li-poly cells, remember: never charge them inside the model!

Install your battery pack with Velcro so you can shift it back and forth to get the CG position as shown on the plans. The finished, ready-to-fly model should weigh approximately 35 to 40 ounces. Aileron and elevator control throws should be around 3/8 inch up and down measured next to the fuselage. I have used APC 5x5 and 6x4 props, and they seem to work well in a direct-drive setup.

I hope you have as much fun building and flying your Mosquito as I did designing it and David did building it! If you need help, feel free to email me at mrittinger70@hotmail.com. Good luck and good flying, old chaps!

APC; distributed by Landing Products (530) 661-0399; apcprop.com.

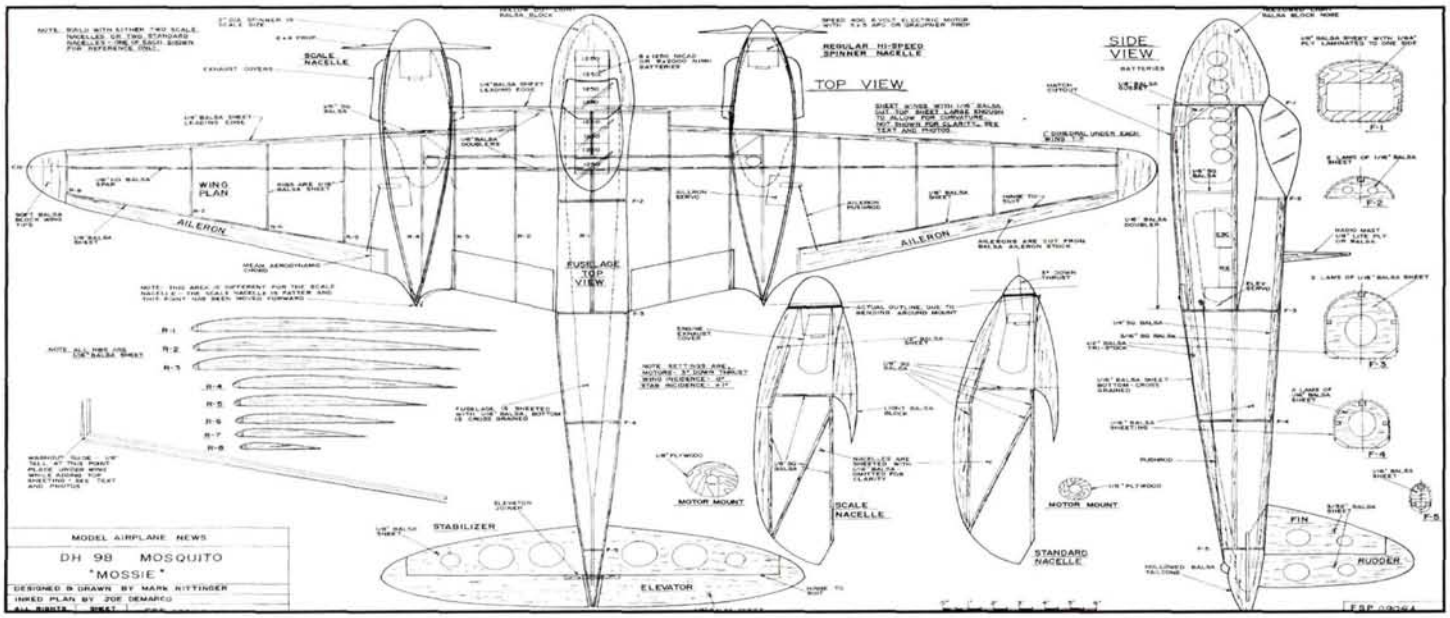
***Dymond Modelsports USA Ltd.** (888) 4FUN FLY; (920) 303-1100; rc-dymond.com.*

***Graupner;** distributed by Hobby Lobby (615) 373-1444; hobby-lobby.com.*

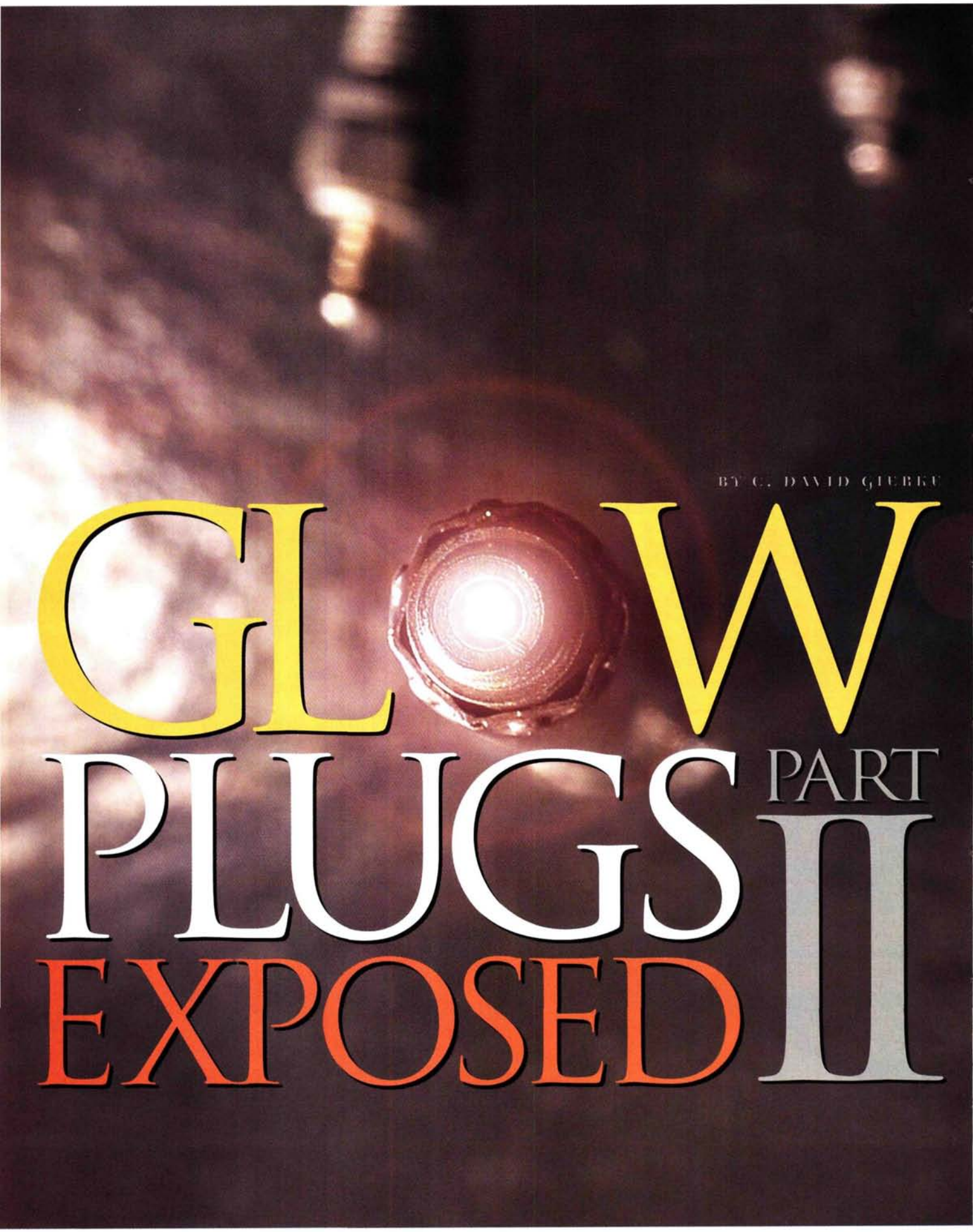
DH MOSQUITO
FSP0904A

Designed by Mark Rittinger, the twin electric-powered WW II British D.H. Mosquito flies great and can be powered by various Speed 400 motors. Balsa and ply construction is used throughout, and the model features a one-piece design.

WS: 44 in.; L: 34 in.; power: twin Speed 400 motors; radio: 3-channel; 1 sheet; LD 2. **$19.95**



To order the full-size plan, turn to page 221, or visit rcstore.com online.



BY C. DAVID GIERKE

GLOW PLUGS EXPOSED PART II

The rest of the story

Glow plugs may be small, but using the right one can make a world of difference to your engine's performance. In Part I of this article, published in the August 2004 issue of *Model Airplane News*, we learned how glow plugs work and why different types are more suited to various engines. This month, we'll discuss how to select a glow plug with the right temperature rating for your engine, how to solve common glow-plug problems and how to "read" your glow plug to get the upper hand on its performance and on your engine-mixture setting.

To review, the factors that determine the engine's ignition point timing include: glow-plug temperature rating, percentages of nitromethane and lubricating oil in the fuel, propeller size, compression ratio, weather conditions and the engine's mechanical condition. The goal is to manipulate these factors to achieve the ideal peak cylinder pressure location ("sweet spot"), where maximum engine performance and longevity will be realized.

Besides adjusting the engine's air/fuel ratio with the primary needle valve, the next tuning factor is often the glow plug's temperature rating. Here are some pointers for selecting the correct glow plug for those who are willing to do a bit of experimenting:

* Use the highest temperature rated plug that will not produce detonation when the mixture is leaned to peak rpm. Detonation produces a sound like eggs frying in a 2-stroke engine and a rattling sound in a 4-stroke.

· If the engine detonates when the needle valve is leaned toward peak rpm, the plug's temperature rating is too high for the combination of variables (fuel, prop, weather, etc.). Switch to a plug with a lower temperature rating.

· If engine rpm drops when the starting battery is disconnected, the plug's temperature rating is too low. Switch to a plug with a higher temperature rating.

· When the starting battery is removed and the needle valve is leaned to peak rpm—without detonation—the glow plug temperature rating is close to optimum for the fuel, propeller, weather, etc.

· If you use fuel with a high percentage (more than 30 percent) of nitromethane in a pattern 4-stroke engine, a helicopter 2-stroke engine, or a club field sport-racer application, a low-temperature-rated plug is recommended. (See sidebar, "Nitromethane: its effect on ignition point.")

PHOTOS BY PETE HALL • ILLUSTRATIONS BY RICHARD THOMPSON

GLOW PLUGS EXPOSED PART II

TEMPERATURE RATING SYSTEMS

Manufacturers supply us with glow plugs that have been assigned specific temperature ratings. Unfortunately, these ratings differ among manufacturers. An example of this discrepancy is the McCoy no. 59 glow plug that's rated "hot." Experience has shown that the McCoy's ignition-point temperature rating is equivalent to the Rossi R5, which is rated "very cold." In a perfect world, all glow plugs would be neatly arranged, from the highest temperature rating to the lowest; engine tuning would be simplified, and we would all live happily ever after.

Since the important elements of glow-plug construction (that affect its temperature rating) can't be calculated with any degree of accuracy, the best alternative is trial and error experimentation:

- Watch engine rpm (with a tachometer) after removing the starting battery from the plug.
- Listen for detonation as engine rpm is peaked and allowed to warm up.
- "Read" the plug (see sidebar, "'Reading' the glow plug.")

An inexpensive, experimental method for determining the temperature rating of a glow plug has yet to be demonstrated. Here are some ideas. A glow plug's temperature rating could be determined if it were possible to accurately measure the engine's ignition-point timing in terms of degrees of crankshaft rotation before top dead center (TDC). The more advanced the ignition point, the "hotter" the plug (with all other variables constant). A cylinder-pressure transducer can do the job, but it must be extraordinarily fast to detect the first hint of pressure rise due to combustion. The necessary pressure transducer, data acquisition and software technology exist (e.g., Hi-Techniques Inc. REVelation), but the cost is prohibitive. Who is willing to invest $75,000 to establish a temperature rating system for glow plugs? Auto racing's Formula 1 and certain NASCAR teams use this technology to optimize the performance of individual cylinders on their racing engines.

There may be other ways to measure the ignition point, including an accelerometer mounted to the outside of the engine's cylinder, as suggested by engine authority Luke Roy. Could detecting the onset of the engine's shake be used to determine the onset of combustion?

Another tactic might be to run the test engine with a glow plug that has yet to be temperature-rated by adjusting the needle valve to its maximum rpm while allowing

continued on page 116

"READING" THE GLOW PLUG

For decades, "reading" the condition of the glow plug has provided experts with information about the suitability of the plug's temperature rating as well as the engine's mixture setting. Because speed fliers and pylon-racing specialists often replace the glow plug after each run, they have the opportunity to inspect the plug's platinum-alloy wire element on a regular basis. Here's what you can learn from its physical condition:

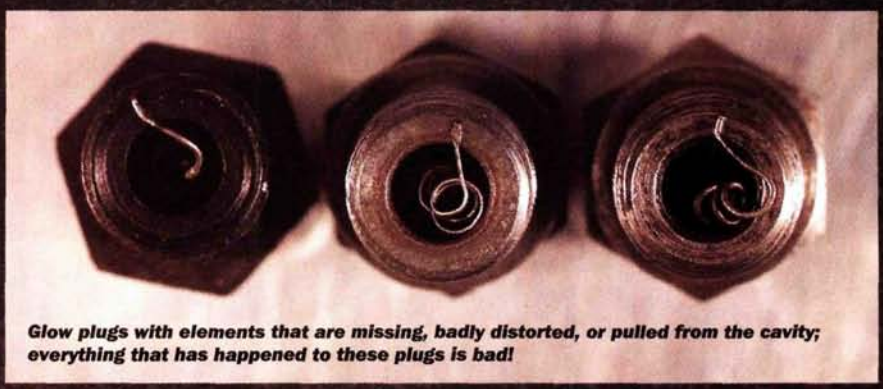
A relatively new-looking plug with a shiny coil and a clean cavity indicates that the engine has been run excessively rich and/or under-compressed.

· **Shiny coil with a clean element cavity.** The shiny coil indicates that the air/fuel mixture has been consistently rich or the engine is under-compressed. The clean cavity also suggests that the plug is relatively new.

· **Gray coil with a brown or black element cavity.** The gray element represents a microscopically pitted surface that could fail, i.e., a wire could break, at any time. The varnished element cavity indicates that the plug has been in use for quite some time, and its failure is imminent.

· **Slightly gray coil with a slightly brown element cavity.** This plug has been in use for a while, but indicates a satisfactory (slightly rich) air/fuel mixture setting—especially if the coil hasn't been distorted (as in sport flying). Note: to a speed or racing enthusiast, this plug, along with a slightly distorted element, indicates a nearly perfect run!

· **Missing element, badly distorted element, or element pulled from the plug cavity.** Many factors can contribute to these conditions, including a lean mixture setting, excessive compression ratio, elevated nitromethane content (fuel), too much propeller load, adverse weather conditions, or a combination of the above. Correction involves one or more of the following: use a lower temperature rated (colder) glow plug; lower the compression by adding a head shim(s); reduce the fuel's nitro content, and reduce the diameter and/or pitch of the propeller. Because a missing glow-plug element can ruin the engine's piston and/or sleeve, the cylinder head should be removed so that you can pick out any pieces of the wire element (a toothpick works well) that may remain on the piston, head, or cylinder wall before running the engine again.



Glow plugs with elements that are missing, badly distorted, or pulled from the cavity; everything that has happened to these plugs is bad!

NITROMETHANE: ITS EFFECT ON IGNITION POINT

There has been some discussion on whether nitromethane advances or retards an engine's ignition-point timing. I'll attempt to clarify this issue with the following example:

Problem: after the engine has been started and the glow-plug battery removed, the rpm immediately drops by 300 as indicated by an accurate tachometer.

Analysis: an rpm drop suggests that the ignition-point timing is retarded (late), compared to when battery heating was applied; this produces a later peak pressure point (after TDC) with reduced cylinder pressure, torque and brake horsepower.

Solution: a retarded ignition point may be corrected in a number of ways including the installation of a hotter plug.

The dilemma: since nitro is very slow burning, adding it to the fuel blend would seem to further retard the ignition point, moving the peak pressure point even farther away from its after-TDC sweet spot. Therefore, why does increasing the fuel's nitro content advance the ignition point?

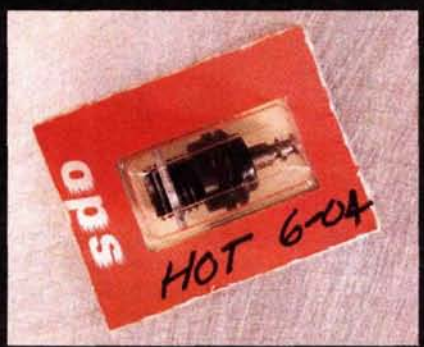
THE THEORY

By increasing the percentage of nitromethane in the fuel blend, we are certain that there is an additional cycle-to-cycle heat release from the combustion process. The extra heat shows up as a temperature boost to the glow plug's wire element, adding to its catalytic action. The increased temperature forces the relatively "cold" plug to act "hotter," initiating an earlier (advanced) and corrective ignition point.

The opposite is true concerning a plug that's too "hot," where the engine begins to detonate when the needle valve is leaned toward peak rpm. A "colder" plug will retard the ignition point. Reduced nitro content, however, will also retard the ignition point by reducing combustion heat release and lowering the plug element's temperature, making the "hot" plug act "colder."

Finally, "cold" glow plugs (usually with thicker wire elements) hold up better under the elevated temperature and pressure rigors of high-nitro (more than 30 percent) fuel blends. "Hot" plugs usually have smaller-diameter wire elements and are susceptible to melting or mechanical damage under these conditions.

INCREASE GLOW-PLUG LIFE AND EFFECTIVENESS



Keep track of your engine's glow plug. Keep the package, and record important information—date of installation, temperature rating, etc.

· When installing a new glow plug, save the package or write down the manufacturer, specifications (long; short; temperature rating), engine and date of installation. Most plugs lack identification, so why trust your memory?

· Never remove or install a glow plug with needle-nose or slip-joint pliers! This will butcher not only the plug body but also the engine's cylinder-head fins. Always use a glow-plug wrench.

· Before removing a glow plug from the engine, clean the area of the head that surrounds it. A generous shot of cleaner from a spray bottle or a short spray of fuel from a syringe will usually clear the opening of any dirt or debris that might otherwise enter the engine as you remove the plug.

· Standard glow plugs have ¼-32 threads. There have been instances where incorrectly cut glow-plug threads have stripped the relatively soft aluminum alloy cylinder head, necessitating its replacement or the installation of a Helicoil. Thinking ahead, engine experts check the threads of all new glow plugs with a ¼-32 die prior to installing them.

Eliminating occasional thread imperfections with a ¼-32 die can prevent damage to the engine's cylinder head.

· When the engine is obviously flooded, spinning the engine over with an electric starter may push the element to one side of the plug cavity; this can change the plug's temperature rating (making it colder), which alters the engine's ignition-point timing and performance. If the engine is flooded, take time to remove the plug from the engine and blow out the flood prior to restarting.

Left: using the correct glow-plug-removal tool minimizes the potential for damage to the plug and engine.

GLOW PLUGS PART II EXPOSED

GLOW PLUG PROBLEMS AND SOLUTIONS

· **Melted element from detonation.** A glow plug's platinum-alloy wire element exists in the harsh environment of elevated temperature and pressure. If the combustion temperature exceeds the alloy's melting temperature (3,200 degrees F), as it would during prolonged detonation, it melts. The solution is to identify and eliminate the cause of detonation (compression ratio is too high; nitromethane content in the fuel is too high; propeller load is too high; glow-plug temperature rating is too high).

· **Melted element from metal particles.** Aluminum particles that contact the glow-plug element will combine with the platinum alloy, lowering its melting-point temperature and causing the wire to "burn" (melt) at that location. Aluminum particles usually originate from the engine's backplate, where they are scraped off by the end of the crankpin or connecting rod. This clearance problem can generally be corrected by installing a second backplate gasket.

· **Silicon poisoning.** Silicon compounds in the fuel blend produce a glass-like deposit on the platinum-alloy wire element, causing it to slowly lose its catalytic action. Although the plug element glows brightly and continues to offer reliable start-up performance, its temperature rating slowly declines (turns cold), and the engine's ignition point retards. When the engine begins to experience idle-performance problems, it's time to replace the plug. Most reputable fuel manufacturers have stopped using silicon compounds as an anti-foaming agent, but some modelers still give each new gallon of fuel a "shot" of Armor All—a kiss of death to the glow-plug element!

· **Broken coil.** Since it's impossible to balance a single-cylinder engine to run smoothly throughout its practical speed range, glow-plug elements have been known to break after having been literally "shaken to death." Vibration is often the culprit if the element wire looks new but a coil is broken. Somewhere within a narrow rpm band of the single-cylinder configuration, moderate to severe vibrations can be expected. Properly balanced multiple-cylinder engines are less prone to vibrate. Because most engines shake to one degree or another, it's important not to load (prop) them to operate within their vibration zone.

· **Leaking glow-plug gasket or stem seal.** A leaking copper gasket or glow-plug stem seal can cause the engine to run lean, overheat and damage various internal components. Check for leaks by placing a drop of oil on the plug gasket and stem (center electrode) while slowly turning the engine over by hand with the propeller in place. Watch for telltale bubbles that verify the leak. If the copper gasket leaks, replace it. If the glow-plug stem seal leaks, replace the glow plug.

HISTORY OF THE GLOW PLUG

Arden introduced the first commercially available glow plug to modelers in the summer of 1947.

The statement, "There's nothing new under the sun" describes many aspects of technology, including the glow plug, which straddles the history of the internal-combustion engine. John Reynolds was the first to use a hot platinum wire (battery powered) in his unsuccessful engine design of 1845. Nicolaus Otto, inventor of the first successful 4-stroke cycle engine, patented a platinum wire-bundle design that was mounted on a poppet valve in 1878. Even Dugald Clerk, inventor of the 2-stroke cycle engine, suggested using a grid of platinum wire within the combustion zone. Inventors rejected the use of platinum wire glow ignition for reasons other than its effectiveness. In his excellent book, "Sparks and Flames" (Tyndar Press, 1997), Crawford MacKeand states, "The electric hot wire igniter ... presented an inordinately heavy load for the batteries of the period [1880s], and so would have required an expensive dynamo [generator]."

Thomas R. "Ray" Arden is credited with introducing the glow plug to model aviation in the summer of 1947. Shortly thereafter, in January 1948, he filed for a patent, which was finally granted in September of 1949. By then, there were at least four companies manufacturing and selling glow plugs for the burgeoning glow-engine market in the U.S. The glow plug was considered by many to be the most influential patent in modeling history, but Arden didn't cash in on his invention; he was too busy defending it in the courts. As a matter of fact, Kenneth Howie of H&H .45 engine fame was granted a patent for an interchangeable "hot-coil" ignition engine in 1937. Unfortunately, because of WW II, Howie didn't get his engine into production until 1947. The H&H

Besides the pioneering Arden glow plug, the McCoy Hot Point, Ohlsson & Rice Kwik-Start and Champion VG-2 plugs were very popular with modelers.

The heavy-duty element-support bar on Champion glow plugs was not designed to be an idle bar.

engine didn't sell well (in fact, it was a flop) because it looked old-fashioned with its obsolete side-port induction system and tall, two-piece crankcase, but it ran great on its glowing platinum-wire element that was mounted horizontally, just below the cylinder head. Modelers, however, paid little attention; they were enthralled with modern glow-engine designs from Fox, McCoy and K&B, as well as the exciting new "baby" (1/2A) glow engines from K&B, Herkimer and Anderson.

After the courts upheld Arden's original patent, he next patented a glow plug with interchangeable hot and cold elements for those who wanted to experiment with various fuel blends. Complicated and expensive to produce, the new plug was a commercial failure due to an element-attachment problem. The hot/cold idea, however, represented the first

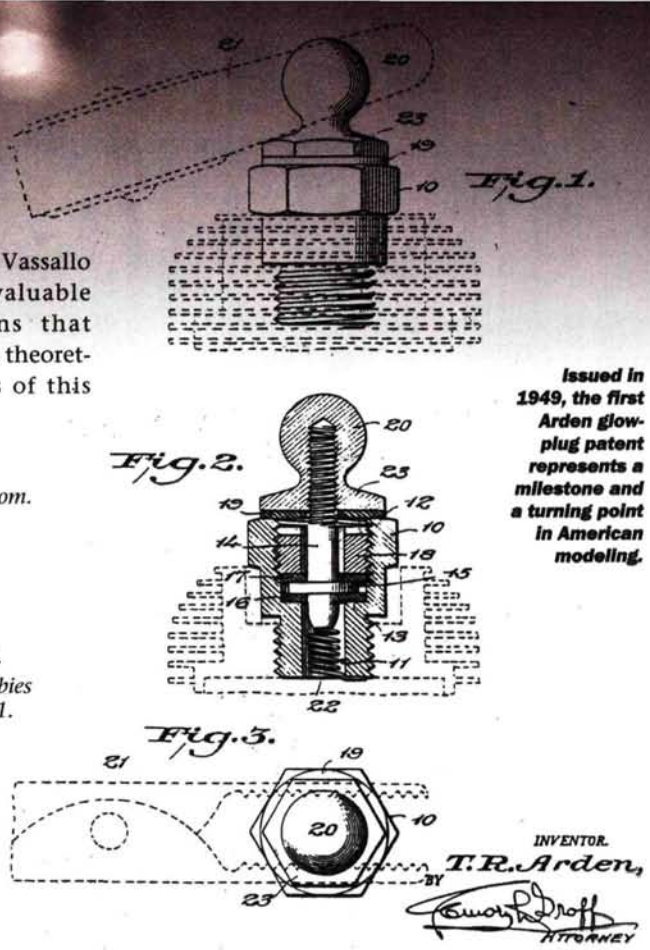
GLOW PLUGS PART II EXPOSED

the engine to temperature stabilize. Shut the engine down. Next, switch to a spark plug and spark-ignition system. Restart the engine; allow it to temperature stabilize while retaining the previous needle-valve setting. By manual or electrical means, adjust the advance-retard mechanism to obtain the same engine rpm. Shut the engine down. With the aid of a crankshaft-mounted degree wheel, carefully determine the ignition point in terms of degrees of crank rotation before TDC. Although tedious and time-consuming, this procedure might provide meaningful glow-plug temperature ratings that all engine-tuners could use.

With or without a temperature-rating system, there is no "best" glow plug for all engines and applications. The good news is that there is a glow plug that's best suited for your engine. The bad news is that you need to hunt for it!

Special thanks to Frank Vassallo and Luke Roy for their valuable insights and suggestions that helped immensely with the theoretical and practical aspects of this undertaking. ✚

Enya; distributed by MRC (732) 225-2100; modelrectifier.com.
***Fox Mfg.** (479) 646-1656; foxmanufacturing.com.*
***K&B Model Products Inc.** (626) 359-9527; modelengine.com.*
***McCoy Racing** (626) 359-0016.*
***Rossi;** distributed by Morris Hobbies (800) 826-6054; (502) 451-0901.*
***SuperTigre;** distributed by Great Planes Model Distributors (217) 398-6300; (800) 682-8948; greatplanes.com.*



Issued in 1949, the first Arden glow-plug patent represents a milestone and a turning point in American modeling.

A vintage K&B "greenhead" .19 (1952) fitted with K&B's early speed-control system. When operating from the low-speed needle valve, the engine was forced to run "4-stroking" rich. To avoid a sudden flameout, the first idle-bar glow plugs were employed.

The Fox idle-bar glow plug has been in production for almost 50 years. The bar is machined as part of the plug body and will not detach during the rigors of engine operation.

attempt at controlling the glow engine's ignition -point timing by altering the plug's temperature rating. Arden glow plugs were the first to use platinum-iridium alloy elements, which proved to be tougher than pure platinum. By the mid-1950s, Fox and Enya began manufacturing glow plugs with platinum-rhodium alloy elements; it was claimed that they were less brittle and exhibited a superior idle.

The glow plug created excitement among modelers after 1947, but it generated sleepless nights for manufacturers of spark-ignition engines who were caught with large inventories. In his "The Glow Plug Engine, 1950-'65," the late Art Suhr summed up the dilemma: "Most [manufacturers] simply modified their [ignition] engines slightly and sold them as glow models. A common practice was to offer them as either a spark or glow model. The glow model was usually [sold] minus the [ignition] timer assembly and plastic tank, although a few companies modified the heads, connecting rods and other critical components."

For glow-plug manufacturers, the early days weren't exactly a picnic; they often experienced serious quality-control problems. Modelers were alarmed to discover electrical shorts, loose center electrodes, leaking seals and insulating materials that softened when heated. Electrical resistance varied within certain brands, indicating that adjacent coils within the element were touching. Reduced resistance increased the likelihood of burnout when connected to the starting battery. Modelers were advised by magazine columnists to inspect element coils and "adjust" them with a pin if they were touching! The learning curve for glow plugs, like that of any new technology, was steep.

Spot-welded into place, idle bars have been known to come loose and cause catastrophic internal-engine damage.

IDLE-BAR PLUG

Liquid fuel directed at the glow-plug element during throttling (idle and acceleration) results in a quenching action. The idle-bar glow plug helped to partially resolve the problem. Although its origins are obscure, one thing is clear: Champion did not make a conscious effort to develop the technology. In fact, the Champion glow plug appears to be another splendid example of serendipity—the faculty for making fortunate and unexpected discoveries by accident. Ted Martin, an early engine expert who wrote for *Model Airplane News* in the early 1950s, said: "One apparently excellent means of securing filament [element] support is the use of a bar across the mouth of the plug, with the filament fused to its center, as featured in all Champion plugs. This bar, incidentally, is not a shield, and the Champion may be classed as a free-mixture-flow type." The first throttling, twin-needle valve, glow-ignition engines weren't produced until 1952—three years after the introduction of the Champion glow plug.

When the twin-needle engines of K&B, Fox and Cameron had difficulty transitioning to high speed from a very rich idle, it was discovered that the Champion glow plug offered better performance than plugs that didn't have an element attachment bar. Other plug manufacturers took note, and the idle-bar plug was born. Duke Fox is credited with introducing the one-piece idle bar glow plug in the mid-1950s. Prior to this, all idle-bar plugs used spot-welded bars that occasionally broke loose, causing catastrophic mechanical damage to the engine. Regardless, to this day, most idle-bar glow plugs continue to be spot-welded.

Three Ways to Build a Battery Pack

If you fly electric models, one thing is certain: sooner or later, you'll want to build a battery pack. There's no magic involved, and the following steps provide you with three approaches to the process. Most of you already have the necessary equipment, and by building your own packs, you can configure them any way you want. You can also remove and replace defective cells without replacing the whole pack. Be sure to check the voltage of each cell before you solder it into a pack; you don't want to use a dead cell by mistake.

1 BRAIDED PACKS

When cells are soldered upright, they have to be restrained. Place a drop of hot glue between the cells to keep them in position. Each cell can then be tinned with a bit of solder. To help prevent the battery braid from melting the cell's shrink-wrap and shorting the cell during soldering, I place a small piece of heat-shrink tubing around the center of the battery braid. Some modelers prefer to use a small piece of cardboard under the braid. Make sure that you've oriented the cells properly so that you're connecting them in series (positive post to negative post). Double check the cells before you start to solder.

Place the heat-shrink tubing on the braid and then shrink it. As you attach each braid, the solder joint should be bright and shiny; if it isn't, you've got a "cold solder joint," and you need to redo it. If you look closely at the photo (below left), you can see the hot glue drops that secure the cells.

The finished pack (below right) has two packs of 4 cells connected by a solder joint on top of the 2 cells at the far right. Once a pack is complete, I always charge it the first time at 1/10C to equalize the cells.

Above: the first braid is held in place with the shrink-wrap (arrowed) that insulates it from the cell's edge. Left: each braid in this pack has been insulated with shrink-wrap.

Use a few drops of hot glue to hold the cells in position for soldering.

The finished pack is sturdy and durable!

2 STICK CONFIGURATION PACKS

Now we'll build a stick pack in which the cells are soldered end to end. I placed tape over the cell on the right to make a bib and then cut its center out with the sharpened brass tube. You can use scissors or a sharp hobby knife to trim the outer edge so it fits the cell. The bib is placed on the positive end of the cell (button), and that helps prevent little bits of solder (slag) from shorting the button to the cell's case. Before you start, tin each cell lightly. Use a hammerhead tip on your soldering iron; it makes building these packs much easier. They are available from Hobby Lobby and New Creations R/C.

The cells must be aligned before you solder them; use a slotted channel board instead of drops of hot glue to secure them. Place two cells in the channel (positive post to negative post). Place the hammerhead between them, push the two cells against the iron for a few seconds and then pull the iron out. This step happens very quickly, and if you use too much solder, it will splatter out from between the cells. Be sure to wear your safety glasses! As soon as you pull out the hammerhead, quickly and firmly push the 2 cells together and hold them in place until the solder has hardened. This takes only a few seconds. Repeat this step for each cell you add to your stick.

To clean any slag between the cells, I use dental floss and then hold them up to a light to ensure that I have a good, clean joint. If there is a large blob or small chunks of slag between the cells, they'll have to be re-soldered. Next, you need to solder the connector leads to the pack. To reduce strain on the leads, attach the leads and run them down the center of the pack before you add the shrink-wrap.

In an end-to-end pack, each cell is soldered directly to the next one. Note the hammerhead soldering tip and the bib on the cell on the right.

I use a slotted channel board to align the cells and hold them while I heat the positive end of one cell and the negative end of the other cell before I join them.

When the solder has melted, push the cells together very quickly. If you use too much, hot solder will splatter out from between the cells. Be sure to have your safety glasses on!

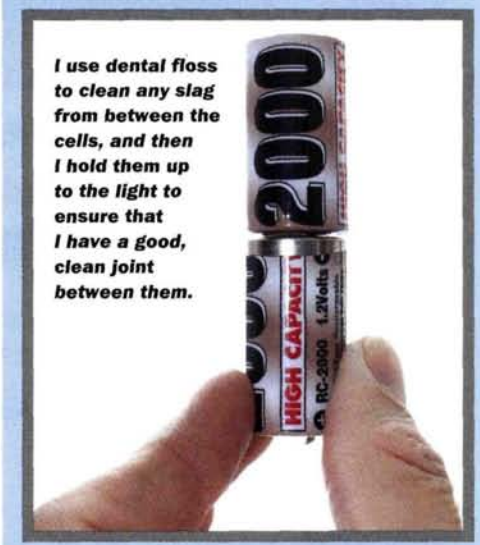
TOOLS OF THE TRADE

To solder cells to each other, you'll need a 40W iron with a wide tip, as it applies a lot of heat to the ends of the cell in a short time. The ends of the cells must be thoroughly cleaned before you solder; I use a Scotch-Brite pad for this. Never use steel wool because the steel fibers can shed and cause a short circuit. After I've scuffed the ends of the cells, I wipe them with acetone.

Stick packs are configured with the cells end to end, and they need to have a "solder bib" between the cells to prevent a short circuit. I use masking tape to make bibs and the sharpened end of a brass tube to cut the centers out of the bibs. To hold side-by-side packs together, I use narrow tape, but you can use shrink-wrap. For the least resistance, I use flat battery braid to connect the cells. When you build a pack with the cells end to end, use a hammerhead tip to heat two cells at the same time.

You need only basic soldering skills; just make sure that everything is clean and tinned. Don't forget your safety glasses—they're a must when soldering.

Above and right: here's what you need to build your own battery packs.



I use dental floss to clean any slag from between the cells, and then I hold them up to the light to ensure that I have a good, clean joint between them.

To reduce strain, I ran the wires to the connectors between the two sticks and under the clear shrink-wrap.

3 SOLDERLESS POWER TUBES

What if you don't want to solder, or you're just not very good at soldering? No problem, thanks to Solderless Power Tubes (SPT) from MEC (Model Electronics Corp.). Pete Peterson has been selling this system for years, and he continues to perfect it. With SPTs, you can easily assemble end-to-end packs of any size in a matter of minutes, and if you have a defective cell, they allow you to disassemble a pack and replace it easily. Let's see how it's done.

Once again, be sure to clean the tops and bottoms of each cell. MEC has recently begun to include silver paste with SPTs to coat each cell before pack assembly to reduce current loss by pressure-fitting them instead of soldering them. A little paste goes a long way, so only use enough to make the cell's button look dull; apply it to the top and bottom of each cell before you slide them into the tubes.

Just as when you solder, position the cells end to end in each tube. Note that the tubes are shaped like a double-barreled shotgun. Check the orientation of each side to make sure that they are correct; to avoid confusion, use the labels in the SPTs as guides.

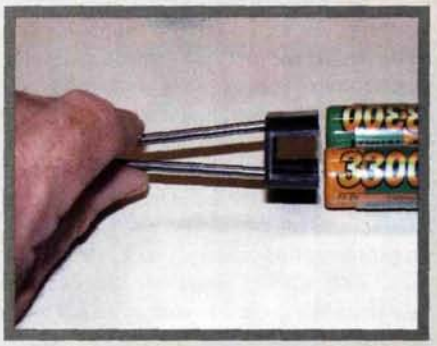
Each endcap has a pair of holes into which two long nails will fit perfectly. The caps can be difficult to fit over the end of each tube, so the nails spread the cap apart just enough to position it easily over the end of the tube. Be sure to have the copper connecting bar in the cap before you install it, as it connects the two sticks. You'll know the pack is assembled correctly when one stick has a positive button exposed and the other has a negative exposed. Double check the polarity.

Now that the tubes have the cells and the cap installed, the assembly has to be secured; use threaded rods and couplers. The MEC kits have rods that are cut to length and use threaded barrels instead of hex nuts. This keeps everything enclosed and helps prevent you from over-tightening the rods. The idea is not to crush the cells together but just to snug them together firmly.

The SPTs can be wired in many configurations, but one of the most common is to connect two, 8-cell SPTs in series to form a 16-cell pack. I'm sold on the SPTs for all of my sport models, and the new silver paste significantly reduces the resistance of each joint.

Solderless Power Tubes make building end-to-end packs easy. The top pack has been completed; at the bottom, the packs are unassembled.

To improve the conductivity between cells, I use silver paste to coat each cell's contact prior to assembly.



After the cells are inserted into the tubes, use a couple of nails to spread open the endcaps so they can be easily positioned on the tubes.

After the endcaps are installed, a threaded rod and couplers hold the assembly together.

Here are two, 8-cell tubes connected together in series to form a 16-cell pack.

CONCLUSION

There you have it: three ways to build battery packs. Buying cells in bulk saves you money and allows you to configure them any way you like. Once you perfect your method, you'll find it takes only a short time to do. Big packs or small—the process is the same. In my next column, we'll look at the connectors that we use in large electrics. ✈

Hobby Lobby Intl. (615) 373-1444; hobby-lobby.com.
MEC (Model Electronics Corp.) (425) 255-4269; (866) 507-9956; model electronicscorp.com.
New Creations R/C (936) 856-4630.

PHOTOS BY GERRY YARRISH

Top Gun Team Scale winner Graeme Mears used ModelCAD to draw his plans for his nearly perfect ⅓-scale Piper PA-18 Super Cub. His static score was less than half point below a perfect score of 100!

MODELING WITH CAD

A popular topic that keeps popping up in the old mail bag is Computer-Aided Design (CAD) and its use in designing big models. Today, many kits have been developed using CAD, and these files are then used to produce kit parts. Laser cutters, CNC-driven routers, milling machines and even high-pressure water cutters (for metal parts) can be driven using CAD programs. For this column, I thought it would be fun to go through some of the basics for developing a set of model plans using a CAD program!

WHERE TO START

First, you can't just buy a CAD program and expect to start drawing plans overnight. Check out the various CAD programs available online and pick one that matches your budget and computer requirements. Once you've installed it on your PC, play with it until you can draw all the basic shapes and line types, and from there, you'll learn how to develop various geometric shapes. Several programs come with helpful tutorials on the basic functions of the program. If you really want to get into CAD, you can take classes to speed the learning process. Once you've mastered the basics, you can start developing your own model airplane plans.

There are two directions to take: you can design your own models and develop unique sport planes, or you can develop scale 3-view drawings and reverse-engineer them into workable model plans. The latter is what I discuss in this column, and here are some words of advice: before you start using a CAD program, study other people's plans to see how they laid them out and how they solved basic engineering and structural issues. This will help you understand the proper size of wood to use for specific purposes, the proper spacing of formers and ribs, and other such topics. Refer to drafting and drawing books, too, so you can develop a good sense of how things should look when drawn in top, side and front views. A working knowledge of drafting is a basic requirement for using CAD, so don't put the cart before the horse.

Find good-quality, detailed, 3-view drawings and scan them into a file that can be imported into your CAD program. Try to find a drawing with a few cross-sections shown. With PC-based programs, this would be a bit map (.bmp) format, and for you Mac users, a .pict file will do. You could use other formats, but these are the most popular. With the image imported into your drawing file, you can begin tracing it with the various drawing tools at your disposal. And it is here where many wannabe CADsters run into difficulty. When I started drawing plans, I began with simple airplane designs. Old WW I biplanes and homebuilts have fewer curved lines and are relatively less complicated to draw than more modern aircraft. Start simply, and work up to the curvier designs.

Here are my rules for drawing with CAD:

›› USE LAYERS. Import your image and assign it to a specific layer. With my *DrawingBoard* program, I assign the image to Layer 1, and I rename it "3-view." Place all the other drawing and details you add on their own separate layers. I typically trace the 3-view and then place the structure (formers, ribs and outlines of other parts) on a separate layer named "Plan." Details such as the engine, servos and such go on a "Hardware" layer and so on. In this way, you can look at specific items, or you can look at them all at the same time. Using layers really helps keep things straight in your head!

›› USE REFERENCES. Start all plans with a centerline or a reference line. From this, you can ensure that things like ribs or formers are drawn square with or parallel to one another. Vertical and horizontal reference lines also are important when you develop fuselage former shapes.

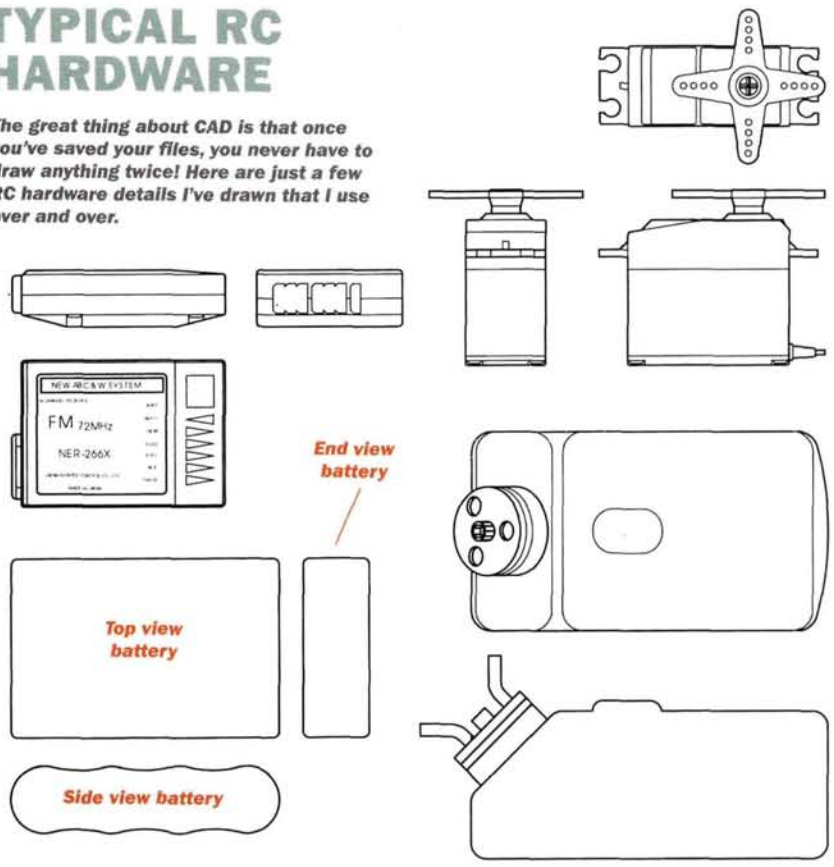
›› THINK SYMMETRICALLY. When it comes to things like wings and fuselages (in top view), draw only one half and then copy and paste a mirror image to it to complete the drawing. Do all the work on one side of the centerline, and then duplicate it and flip it over to produce the other half. This ensures exact symmetry and cuts the work in half!

›› SAVE DETAILS. Never draw anything twice! Draw things like engines, electric motors, servos, receivers, control horns, etc. once, and then save them into a master file. Drawing these things in top, front and side views is also a great way to hone your drawing skills. After you have saved them, you can copy and paste them into new drawings. You can also enlarge or shrink them to make new master details.

›› USE THE TOOLS. The palettes included with all CAD programs have many useful drawing tools and functions. It is always easier to use these tools than to draw freehand over your imported 3-view drawing. Geometric drawing tools for circles, squares, ellipses and arcs are all easy to use, and they'll make your drawings cleaner and more precise. Wingtips, engine cowls and other parts are easily reproduced by combining segments of ellipses and straight lines.

TYPICAL RC HARDWARE

The great thing about CAD is that once you've saved your files, you never have to draw anything twice! Here are just a few RC hardware details I've drawn that I use over and over.



›› WORK INWARD. After you've drawn your reference and centerlines, draw the outline of a wing half top view, fuselage side view, tail surfaces top views and half of the fuselage top view. From here, you then establish the locations of main formers, doublers, landing-gear mounts, wing spars, ribs and so on.

›› AIRFOILS. Investigate the many sources of downloadable airfoil plots or consider using an airfoil-generator program. These will save you hours of tedious airfoil layout work.

Above all else, remember that this is a hobby, so using CAD should be fun! For many, drawing plans can turn into another major part of the hobby. Before you know it, you'll have a whole collection of model CAD plans to show off to your friends. The hard part will be picking which ones to build and fly!

CAD PROGRAM SOURCES

PROGRAM	CONTACT INFO	COMMENTS
AutoCAD LT 2005	usa.autodesk.com	2D drafting; easy sharing and simplified plotting.
DesignCAD Express Version 14	upperspace.com	Complete CAD program.
ModelCAD	upperspace.com	CAD system specifically designed for PC and scale modelers.
WingMaster	upperspace.com	Airfoil design program.
Graphite	ashlar.com	Native Mac OS X compatibility 2D/3D precision wireframe; 2-week free trial download available.
TurboCAD	imsisoft.com	2D/3D design application; free trial; download available.
SmartDraw	smartdraw.com	Free download.
CAD Depot	caddepot.com	Source for CAD freeware and trial downloads.

GRAPHITE

Ashlar-Vellum's *Graphite* is one of the easiest CAD programs I have ever used. It's an excellent 2D drafting tool that can be used to develop model airplane plans. Marketed as a professional 3D CAD program, *Graphite* costs $995—obviously not intended for the general public, but it should be! My previous experiences with the *DrawingBoard* (*DB*) program made me feel that *Graphite* was an updated version of *DB*.

Graphite has a very simple workscreen layout; it looks more like a simple art/drawing program than a powerful CAD program. The tool menu, which includes the various line, circle and polygon tools, is at the left of the screen. Finding and

using the tools is simple and intuitive. The program comes with an excellent users' manual as well as a "Getting Started" booklet; combined with its program tutorials, *Graphite* is as user-friendly as can be.

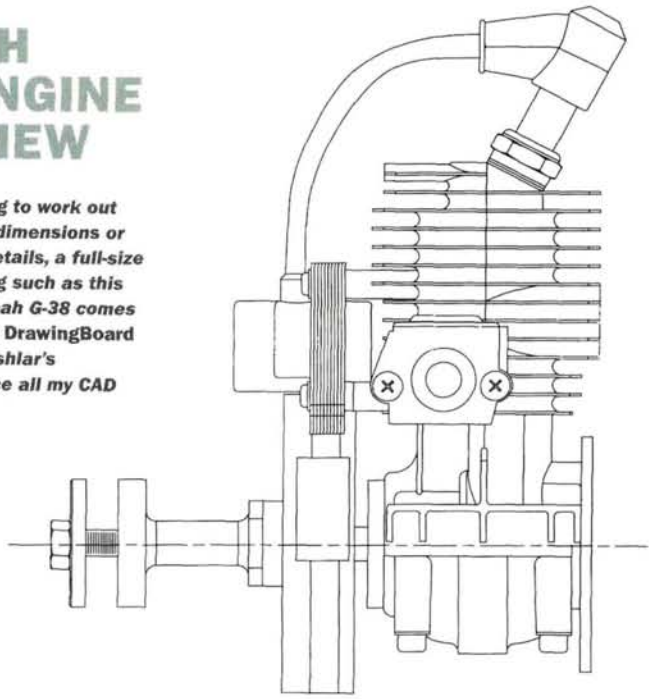
Graphite has an awesome alignment system that allows you to very precisely move and connect lines and other objects. Known as the "Drafting Assistant," this alignment feature replaces typed command inputs and replaces them with simple mouse clicks and drag-and-drops! *Graphite* also has an excellent set of line-trimming tools and a large library of often-used drafting symbols.

The big difference between *Graphite* and *DB* is the additional 3D drawing tools. To create items in an isometric view requires you only to draw a top view and then to enter a menu command to tell the program that you want a "Trimetric" view or "Wire Frame." You can even move the item in all three axes; nothing could be easier!

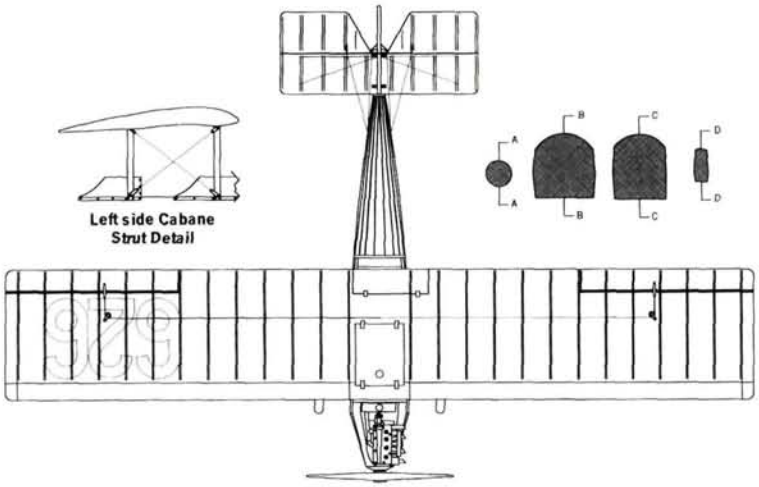
Look for a complete review of *Graphite* in an upcoming issue. Until next time, use those CAD programs and practice, practice, practice! ✈

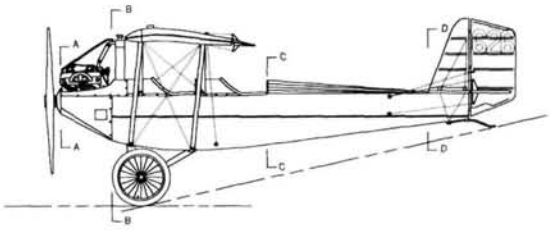
ZENOAH G-38 ENGINE SIDE VIEW

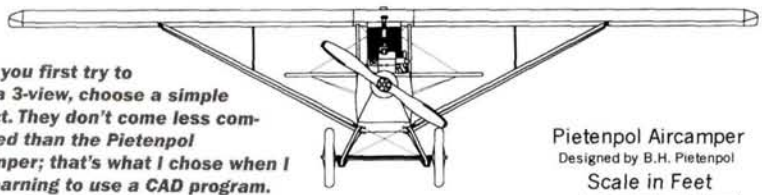
When you are trying to work out firewall-to-spinner dimensions or engine-mounting details, a full-size CAD engine drawing such as this side view of a Zenoah G-38 comes in very handy. I use* DrawingBoard *(now replaced by Ashlar's* Graphite*) to produce all my CAD drawings.



PIETENPOL AIRCAMPER 3-VIEW







When you first try to draw a 3-view, choose a simple project. They don't come less complicated than the Pietenpol Aircamper; that's what I chose when I was learning to use a CAD program. Here, you can move on to sizing your plans and then adding all the model structure details later.

Pietenpol Aircamper
Designed by B.H. Pietenpol
Scale in Feet
0 3 6

Classic Model Airplane News

by Gerry Yarrish

50 years ago ...

... aviation artist Jo Kotula had defined the art of magazine covers. His pens and brushes re-created the excitement responsible for drawing so many young men into aviation careers. For the September 1954 *Model Airplane News* cover, Jo captured the very soul of barnstorming with a wing-walker plying his trade atop a vintage Curtiss Jenny biplane. The on-the-cover blurb on page 2 states that when Jo was a youngster, scenes like this were commonplace, and this cover art drew from one of his many childhood memories!

... engine reviews were very popular reading, and E.C. Martin sang the praises of the new 2-speed K&B .15. With the growing popularity of the .15 engine class, RC fans developed many models to use this engine size. K&B had already produced a single-speed (one needle valve) engine, and this new twin-needle-valve (no carburetor) version produced 14,000rpm on a 7x4 prop.

... Top Flite Models advertised that 113 first-place Nationals winners over the past six years had all used Top Flite props! The famous Carl Goldberg is quoted: "More pull per flight, more flights per prop!" As I look across my office to my workbench, I can't help but notice that my newest fun-fly model has a Top Flite 11x4 wooden Power Point prop on its nose. Some things never change!

25 years ago ...

... the September 1979 cover featured Dave Linstrum's photo of Ed Carroll launching his FAI free-flight model at the 9th U.S. Free Flight Championships in Taft, CA. The article highlighted modelers competing at all levels, from rubber-powered scale and P-30 flyers to powerful D-gas giants. Whether they took off from the ground or were launched vertically, these specialized models flew completely unassisted, relying entirely on the modeler's ability to trim his model before it left the ground!

... giant scale—quickly becoming one of the most popular segments of RC—was helped greatly by the folks at Hobby Lobby. Satisfying the need for "big," Hobby Lobby offered oversize kits and engines. Few big-bird fliers today could ever forget the immense 12-foot Telemaster. Teamed up with Joe Bridi, whose company produced the kits, Hobby Lobby packaged the 12-footer with a 31cc gasoline engine—the Evra 190. Hobby Lobby also offered your money back plus $5 if you didn't think the giant Telemaster was the best kit of its kind!

... model boaters turned to *Model Airplane News* to learn all the latest nitro-competition news. Dave Lee wrote about the '79 Indy Unlimited. This IMPBA-sanctioned hydroplane race featured $6,000 in purse and prizes, making it a big-stakes event for some 137 contestants. Even today, a race with that many contestants would be a big-time event!

... the cover was a montage of 1994 Top Gun aircraft with winner Terry Nitsch's F-86 shown in a close-up fly-by! Then in its 6th year, Top Gun continues today as a world-class scale event.

... expert model airplane designer Andy Lennon continued a popular article on ducted-cowl design that made it easy to understand how to properly cool your engine. Filled with detailed illustrations, Andy's articles went on to become a useful "Model Airplane Design" book that's still available today.

... "Real Performance Measurement (RPM)" columnist Dave Gierke helped countless modelers with his discussion on breaking in "lapped" and "ringed-piston" engines. By offering concise definitions of terms and highlighting a proper break-in procedure, Dave's valuable advice set everyone on the path to success.

10 years ago ...

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VECTORFLIGHT: ARF-quality airplanes made in Canada/USA; Extra 300S, Edge 540, Sukhoi SU31; for 0.60 to 1.00 engines. Online info and ordering at vectorflight.com. [12/04]

RC FLIGHT TRAINING. Learn to take off and land in far western North Carolina, near Murphy. 1635 Setawig Rd., Brassown, NC 28902; (828) 837-7762. [10/04]

HOBBYIST

FOR SALE: Untouched Arizona Model Aircrafters 1/6-scale Fokker EIII (Eindecker); $350. Bill Foster, 101 Labella Lane, Big Arm, MT 59910; (406) 849-5911; jeanabillfoster@centurytel.net. [9/04]

RC VIDEOS AND DVDS. Ducted Fan Jets, Helicopters, Giant Scale, Warbirds, Float Planes, Turbine Jets and YES—CRASHES. Visit our updated website loaded with info and event photos: teamrcpilot.com. [11/04]

USED ENGINES WANTED: pre-1970 preferred. T. Crouss, 100 Smyrna, West Springfield, MA 01089-1706; (413) 732-3859. [10/04]

FOR SALE: 35-year collection of model aircraft plans. Large, small, twin, singles, float planes, amphibians, flying boats, fighters and oddballs. Send SASE for a complete list and prices. W.G. Warner, P.O. Box 55, Gulliver, MI 49840. [11/04]

QUARTER SCALE FLEET MODEL 2 BIPLANE AND 1/8 ELECTRIC FLEET KITS. Concept Models, 6505 Urich Terrace Madison, WI. 53719. SASE for details www.mailbag.com/users/conceptmodels/; (608) 848-4108. [12/04]

WANTED: Need copy of the old VECO P-51 C/L Stunt plan. D. Paric, 32 W. College Ave., Yardley, PA 19067-1517. [9/04]

BACK ISSUES, MODEL MAGAZINES 61 Coach, Glastonbury, CT 06033-3237; davidbrown46@cox.net. [3/05]

R/C VIDEO: featuring aerial views from the pilot's seat; 1/3-scale J-3 Cub, 1/5 Beech Staggerwing and more! 90 minutes; VHS tape—$7.50; DVD-R—$10. Send check to Raymond Keel, 1200 E. Davis St. Ste. 115, Box 192, Mesquite, TX 75149. [4/05]

WANTED: R/C Flight Instruction in North Central Georgia Mountains "Blairsville." (705) 745-8667. [8/05]

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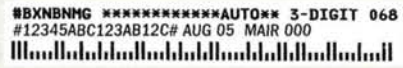

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BY GERRY YARRISH

FINAL APPROACH

The White Knight carrier aircraft flies over the Mojave desert with SpaceShipOne secured to its belly!

PHOTOS COURTESY OF SCALED COMPOSITES

SpaceShipOne

Historic civilian space launch attempt

If events play out as planned, a privately developed rocket plane will be launched into history on June 21 to become the world's first commercial, manned space vehicle. Headed by aviation legend Burt Rutan and financed by Paul G. Allen, founder and chairman of Vulcan Productions, the program will be the first attempt by a non-government-assisted flight to leave earth's atmosphere.

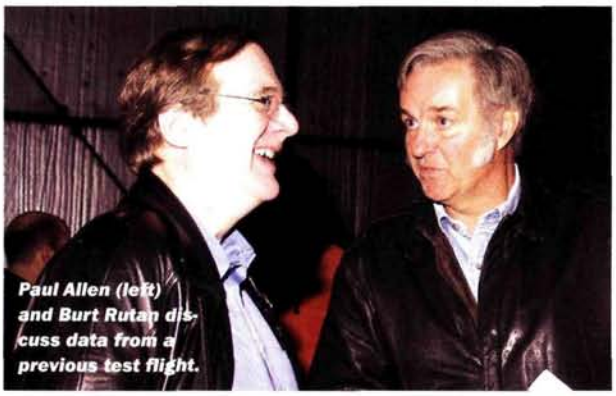
SpaceShipOne will hurtle 62 miles into suborbital space above the Mojave Civilian Aerospace Test Center, a commercial airport in the California desert. (Suborbital space flight refers to a mission that leaves the atmosphere but does not reach the speed necessary for continuous earth orbit.) If the flight is successful, it will signify a new era in which the frontiers of space are finally opened to average citizens.

The plan for the June 21 flight was decided on after a successful May 13, 2004, test flight, in which pilot Mike Melvill reached an altitude of 211,400 feet (approximately 40 miles)—the highest altitude ever reached by a non-government aerospace program.

The mission pilot, who has not yet been chosen for the upcoming June space flight, will become the first person to earn astronaut wings in a non-government-sponsored vehicle and the first private pilot to fly a spaceship out of the atmosphere.

Designed by Rutan and his research team at the California-based Scaled Composites, *SpaceShipOne* will be lifted from the runway by a carrier aircraft called the *White Knight*. After climbing to 50,000 feet, the *White Knight* will release the spacecraft, whose pilot will then fire the main rocket motor for about 80 seconds, reaching Mach 3 in its vertical climb. *SpaceShipOne* will then coast up to its goal altitude of 100km (62 miles) before returning to Earth. The pilot will be able to configure the spacecraft's wing and tail sections into a high-drag, "feather" mode. This will produce an atmospheric reentry much slower than that produced by conventional spacecraft and with less heat buildup. The pilot will then reconfigure the control surfaces back into normal glide mode, spend 15 or 20 minutes gliding the craft back to Earth, and then touch down like an ordinary aircraft on the same runway from which it took off.

SpaceShipOne has a very manageable landing speed of 90mph.



Paul Allen (left) and Burt Rutan discuss data from a previous test flight.

After the flight into suborbital space, SpaceShipOne will glide back to earth.

The June flight will be flown solo, but *SpaceShipOne* has three seats: it's designed to carry a pilot and two passengers. After the June space-flight attempt, *SpaceShipOne* will compete for the $10 million Ansari X-Prize Challenge, an international competition to create a reusable aircraft that can launch three passengers into suborbital space, return them safely home and then repeat the launch within two weeks using the same vehicle.

The public will be allowed to view the takeoff and landing as well as the overhead rocket boost into space. The Discovery Channel and Vulcan Productions are filming "Rutan's Race for Space," a special telecast that will document the entire process of this historic effort for broadcast later this year.